HOME OFFICE

CIVIL DEFENCE
TRAINING MEMORANDUM No. 3

The Control of Civil Defence Operations under Fall-out Conditions

(England and Wales)

LONDON
HER MAJESTY'S STATIONERY OFFICE
1959

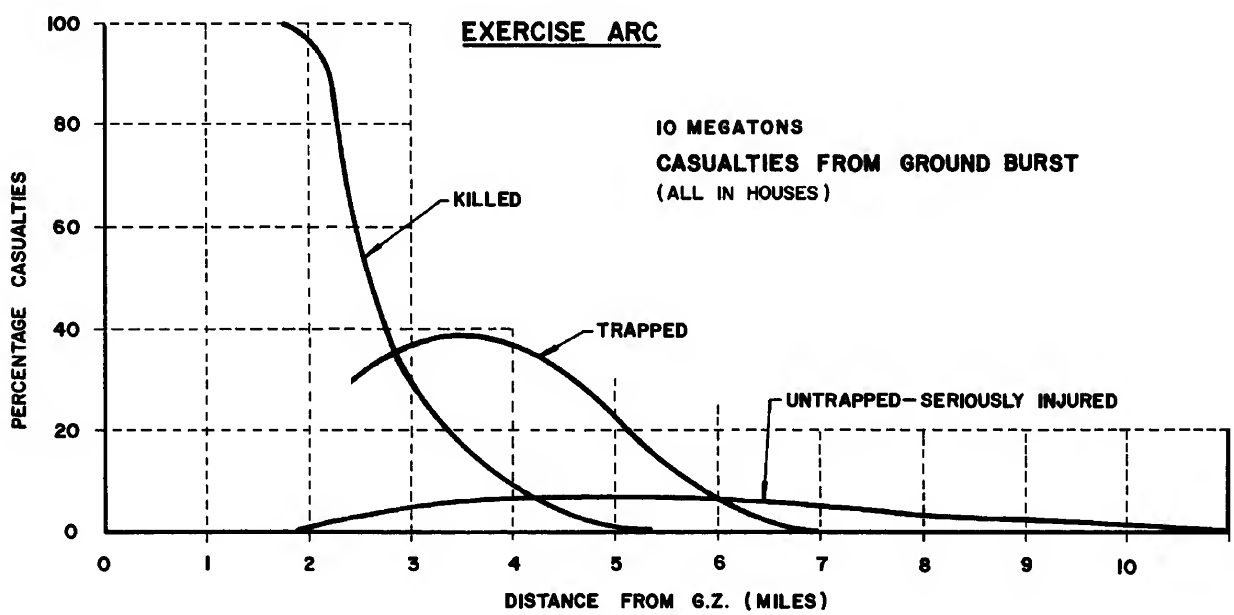
SIXPENCE NET

Civil Defence Training Memorandum No. 3, "The Control of Civil Defence Operations under Fall-out Conditions," U.K. Home Office, 1959

Paragraphs 6-14 explain that the need for rapid life-saving rescue and evacuation from the damaged areas near ground is to be balanced by the fallout gamma dose rate hazard to the civil defence workers; for optimum results first aid and rescue workers should move inwards (toward ground zero) at about the same speed the 10 R/hour gamma outdoor dose rate contour moves inward due to the natural radioactive decay of fallout (because fallout radiation decays rapidly, the dose rate at 48 hours being only about 1% of that at 1 hour):

"The balance of advantage would differ according to the nature of the work; but for the rescue and casualty services it is thought that the best results would be obtained from working at or about a dose rate of 10 R/hour, so that the wartime emergency dose [75 R] was used up in a single shift of about 8 hours. … Some forces, e.g. ambulances, could operate profitably where their dose was spread out over longer periods than 8 hours by working at lower dose rates than 10 R/hour. Others, e.g. reconnaissance parties with special responsibility for rapid penetration, might have to take their wartime emergency dose without heed to the 10 R/hour [fallout map pattern/contour] line and reduce their working period accordingly. … units would continue with their task … with reference only to the total dose accumulated on their dosimeters. … The radiological limit should be taken as the 1,000 R/hour at H + 1 contour which will be 10 R/hour line at H + 48 [due to the 100 fold decay of fallout radiation between 1 and 48 hours after a nuclear explosion] and so mark the limit to which life-saving forces can be expected to have penetrated by that time. …

"The task will be set by the number of casualties trapped, or seriously injured but untrapped … capable of being succoured within the first 48 hours. As soon as possible after ground zero, weight and nature of attack are known, the Controller should have casualty estimates made … This will be done by applying the population figures for the Sectors casualty percentages as shown on the graph (from Exercise ARC) attached as an appendix to this memorandum, which sets out, on the best evidence at present available [blast casualties from applying Blitz casualty data as a function of house damage to nuclear test data showing the amount of house damage versus distance from a nuclear explosion, which automatically takes account of the duration of the blast wave in nuclear explosions], the proportions of seriously injured, trapped and untrapped, to be expected at different distances from ground zeroes of bombs of varying power. … A single Forward Medical Aid Unit can be expected to deal with about 120 seriously injured an hour – say 1,000 in each shift – and to continue working throughout the operational period with only internal reliefs. … At the beginning of operations a 4-berthed ambulance can be expected to take about 1 hour on the round trip from ambulance loading point … A single casualty collecting party can handle and send to ambulance loading points about 12 seriously injured an hour, or, say, 100 per shift [8 hours]. … A single [light] rescue party [using slow manual methods used in 1941, without any of the tracked cranes used and rescue dogs used to rapidly clear debris of casualties in the 1944-1945, during the V1 and V2 attacks on London] can release two or three trapped persons an hour or, say, 20 per shift.



HOME OFFICE
SCOTTISH HOME DEPARTMENT

General Information

(All Sections)

CIVIL DEFENCE
POCKET BOOK NO. 3

LONDON
HER MAJESTY'S STATIONERY OFFICE
1960

Zone	*Dose-rate at H+48 hours*	*Summary of permissible and recommended action*
W	Less than 0.3 r.p.h.	Remain in refuge until released, which can be as soon as dose-rate falls to 0.3 r.p.h. or when fall-out is complete if the rate has not reached that figure.
X	0.3—3 r.p.h.	Remain in refuge until H+48 hours; then qualified release. Indoor workers to follow normal occupations, but not to exceed 4 hours per day in the open for the next 5 days. Outdoor workers would have to do half shifts to keep within this figure. At the end of a week the zone would be normal, except that all would be advised to be out of doors as little as possible, and not in any case to exceed 8 hours per day in the open for the next 3 months.
Y	3—10 r.p.h.	Remain in refuge until at least H+48 hours; then release under stringent control. For the next 12 days time in the oper should not exceed 2 hours per day. On this basis essential indoor workers should be able to get to their work, but outdoor work would remain suspended. After the first fortnight it would be possible to increase the essential time spent out of doors to 4 hours per day for the next three weeks, increasing this to 8 hours per day thereafter for the rest of the first year.
Z	10 r.p.h. or more	Remain in refuge until told to leave. All movement outside refuge in this zone would be dangerous. People should remain until instructions for clearance are given; they should then leave by the nominated route if they have means of transport—or wait in their refuge to be collected if they have not. The clearance operation might start after H+48 hours and removal from the Zone would be for at least 3 months.

HOME OFFICE

CIVIL DEFENCE

TRAINING MEMORANDUM No. 4

The Clearance of Z Zones by Road

(*REVISED* 1965)

(Z Zones are fallout areas where the 48 hour gamma dose rate is above 10 R/hour. This corresponds to a dose rate of 1,000 R/hour or more at 1 hour after a nuclear explosion. The outside dose accumulated from an arrival time of 1 hour after a 1 megaton burst, up to evacuation at 48 hours, is:

$$\text{Dose} = 5 \times 1000 \times (1 - 48^{-0.2}) = 2{,}700 \text{ R outdoors}$$

or 67 R in a brick house's room with blocked windows)

LONDON

HER MAJESTY'S STATIONERY OFFICE

1965

SIXPENCE NET

The Clearance of Z Zones by Road

Introduction

1 This memorandum is concerned with the drill for clearance by road from those parts of a Z Zone which are not in a damaged area. In a damaged area the drill would have to be modified as necessary to meet the special conditions obtaining, e.g. restriction of road access. The memorandum deals only incidentally with the areas to which people will be cleared. It is assumed that 'assembly towns' of, say, from 8,000 to 50,000 population at distances up to about 20 miles from the Z Zone will be selected to receive those cleared; and that the bases from which clearance operations will be mounted will be on the outskirts of those assembly towns commanding main routes into the Z Zone. It may sometimes be desirable to site the clearance bases further forward; in which case staging points will be set up from which people will be transported to the assembly town by train or other means.

2 In clearance the maximum use must be made of all forms of petrol-driven transport, including public transport already within a Z Zone. Families capable of clearing themselves should do so; and wardens should, so far as possible, arrange in advance that spare places are reserved for neighbours. The opportunity should be taken wherever possible to provide for people living in remote areas without their own transport to be collected by private transport on the way out. This will simplify the task of clearance from outside. Instructions to the public will require that houses left completely empty should be marked by the last person to leave by hanging a sheet out of a front window.

3 The proportion of population capable of being moved by transport already in a Z Zone is likely to be substantial but the remainder will have to be cleared by transport sent in from outside.

4 The closest contact will have to be maintained at every level between the warden organisation within the Zone and the clearance forces working from outside. The wardens will be responsible for providing clearance forces with essential information; and, in anticipation of the area coming within a Z Zone, should make the preliminary plans described in Appendix I.

General principles of clearance

5 The physical clearance of a Z Zone would rarely start before H+48 hours although planning might be instituted at an earlier time. The wartime emergency dose of 75r will apply to all engaged. The object will be to clear the Zone as quickly as possible within the limits set by this dose and the size of the forces available.

6 Clearance by night or when visibility is bad, is likely to increase the time of exposure and should be avoided if possible. Delays caused by suspending clearance during the hours of darkness would make little difference to the total dose received by those in their fallout rooms in the Z Zone.

7 For clearance from outside, passenger carrying vehicles with a capacity of not less than 30 should be used. The use of vehicles of lesser capacity would be radiologically extravagant to clearance personnel, and should not be used unless there is no practical alternative.

8 Zones will be cleared inwards sector by sector or district by district. Throughout each sector or county district* council areas in turn self-clearance will be effected first and clearance organised from the outside will then be undertaken as far as possible simultaneously in every warden post and patrol area.

9 Clearance vehicles will operate in convoys of about five. In general one convoy will be allotted to each patrol area. To avoid unnecessary exposure to radiation of their occupants, vehicles should be sent individually to assembly towns as soon as they are loaded unless there is some good reason for acting otherwise. After unloading they will be reformed into convoys at the clearance base.

10 In built-up areas convoys will on their initial trip be directed to the warden posts and from there to the patrol areas they are to clear. In rural areas this method of routing would be radiologically expensive and should be unnecessary. Where the position of a patrol post can be easily indicated on a 1″ map the rule will be for the convoy to go direct to the patrol post in rural areas.

Allotment of responsibilities

11 Overall responsibility for deciding when a Z Zone is to be cleared and where the population of the Zone is to be moved will rest with the Regional Seat of Government which will allot responsibilities to individual Sub-regional headquarters. Responsibility for clearing segments of a Z Zone, and the transport for that purpose will be alloted by Sub-regional headquarters to county or county borough controls. Responsibility for receiving the people cleared will be apportioned to the county or county borough controls within whose boundaries the assembly towns lie. Where responsibilities are separated co-ordination will be maintained by the next higher control, e.g. co-ordination between county or county borough controls by Sub-regional headquarters.

12 A single Z Zone may well extend into two or more Regions and a single Region contain parts of two or more separate Zones. Each Zone will have been given a code name. For clearance purposes segments will be known as Regional, Sub-regional, county, and in some cases county sub, or county borough segments as the case may be, and will be further identified by the appropriate numbers and letters of the responsible control, e.g. county segment (or simply segment) 62A.

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* NOTE: All later references to 'district' refer to 'county district council areas'.

13 Operations will be conducted by clearance units, set up by the responsible control, which will appoint the commanders, establish the bases and give each unit a segment, to be known as a clearance segment, to deal with. The boundaries of clearance segments should so far as is possible follow those of warden sectors or districts if sectors do not exist. Clearance unit comanders will normally be civil defence assistant controllers (Ops) or mobile controllers, unless the unit is provided by the military or by a police mobile column. Within a county or county borough all units, under whatever command, will be lettered in sequence and the same lettering will be used to identify the clearance segments, e.g. (clearance) segment 62AA.

14 A clearance unit should have about 125 buses or coaches, with an average lifting capacity of, say, 5,000 people. One hundred and fifty vehicles (average lifting capacity 6,000) should be regarded as the maximum. The number of lifts that can be accomplished in a day will depend on the time of year, whether the population of the segment is concentrated or scattered, and the length of run to the assembly town or staging point; but it may be expected to vary from about two to four. County or county borough control must judge from these factors the number of units required and the size of the clearance segments to be allotted to each. During the progress of operations there may well be need to adjust either the boundaries of the segments or the strength of the units.

15 It may be necessary for a clearance unit to call in the ambulance resources of counties or county boroughs in order to clear people whose physical condition makes it impossible to transport them by bus or coach. For radiological reasons the use of ambulances must be kept to an absolute minimum. If there should be an acute hospital, containing a large number of patients, in the Z Zone, special arrangements for their clearance and reception would have to be made at county or county borough level or above.

The clearance unit

16 In order that a clearance unit, when clearing each sector or district in its turn, should be able to work simultaneously in every warden post and patrol area within that sector or district it should have an operational staff approximating to the following "standard".

Clearance unit commander (1): to be responsible for organising the clearance of the sector or district generally.

Clearance officers (5): each responsible for organising the clearance of a warden post area and taking charge of a section of five convoys.

Convoy commanders (25): each in charge of a convoy of five buses or coaches operating in a given patrol area.

Drivers and mates will be needed for the 125 buses and/or coaches and drivers for the six cars with which the unit will be provided. Relief bus drivers should be sought as required, if necessary with the help of local Ministry of Labour representatives.

Signal staff and equipment for maintaining communications with the static control, should telephones not be working, and office staff for a mobile control plus six messengers, would also be required.

17 Of the above, the convoy commanders, bus drivers and mates whose duties will take them constantly in and out of the Z Zone, will have to be replaced as and when their wartime emergency doses are expended—perhaps after seven or eight lifts over two or four days. Clearance officers and car drivers and messengers will also enter the Z Zone, but less frequently and for shorter periods; so that in their case replacement should not be necessary for a long time, if at all.
(For administrative staff at base see paragraph 22).

18 This "standard" unit may be varied as required by increasing or reducing the number of buses or coaches and so the size or number of convoys or convoy sections with consequent alterations in the number of convoy commanders or clearance officers. Considerations of administration and maintenance will, however, require an upper limit of 150 vehicles.

19 Whatever unit is employed there will almost certainly be need to make constant readjustment between the various parts during the course of operations; according, for instance, to the number of warden post and patrol areas within whichever sector is being cleared, their populations, and the particular difficulties they present.

20 The designations used in paragraph 13 are entirely functional. Except where a clearance unit is provided by a military formation or a police mobile column its operational staff may be drawn from a variety of sources. (See Appendix III.) It is of great importance that the right people should be found to act as convoy commanders, since these will have the major responsibility for dealing with the public in the Z Zone, and (as will be evident from paragraph 32) the task is one requiring an ability to inspire confidence and the highest qualities of firmness and tact. The work might be undertaken by post or deputy post wardens from areas unaffected by fallout; but it is one for which police officers would be particularly well suited.

The clearance base

21 The essential facilities required for a clearance base are:

(a) Good communications.

(b) Access to adequate P.O.L. supplies.

(c) Hardstanding for the vehicles.

(d) Accommodation for personnel.

(e) Feeding facilities (these might be provided in billets or by Welfare Section emergency feeding teams).

It should be possible for the facilities to be found on the outskirts of most towns. A large bus depot would be ideal.

HOME OFFICE

CIVIL DEFENCE
TRAINING MEMORANDUM No. 6

The Evacuation of Casualties

(*PROVISIONAL*)

LONDON
HER MAJESTY'S STATIONERY OFFICE
1961

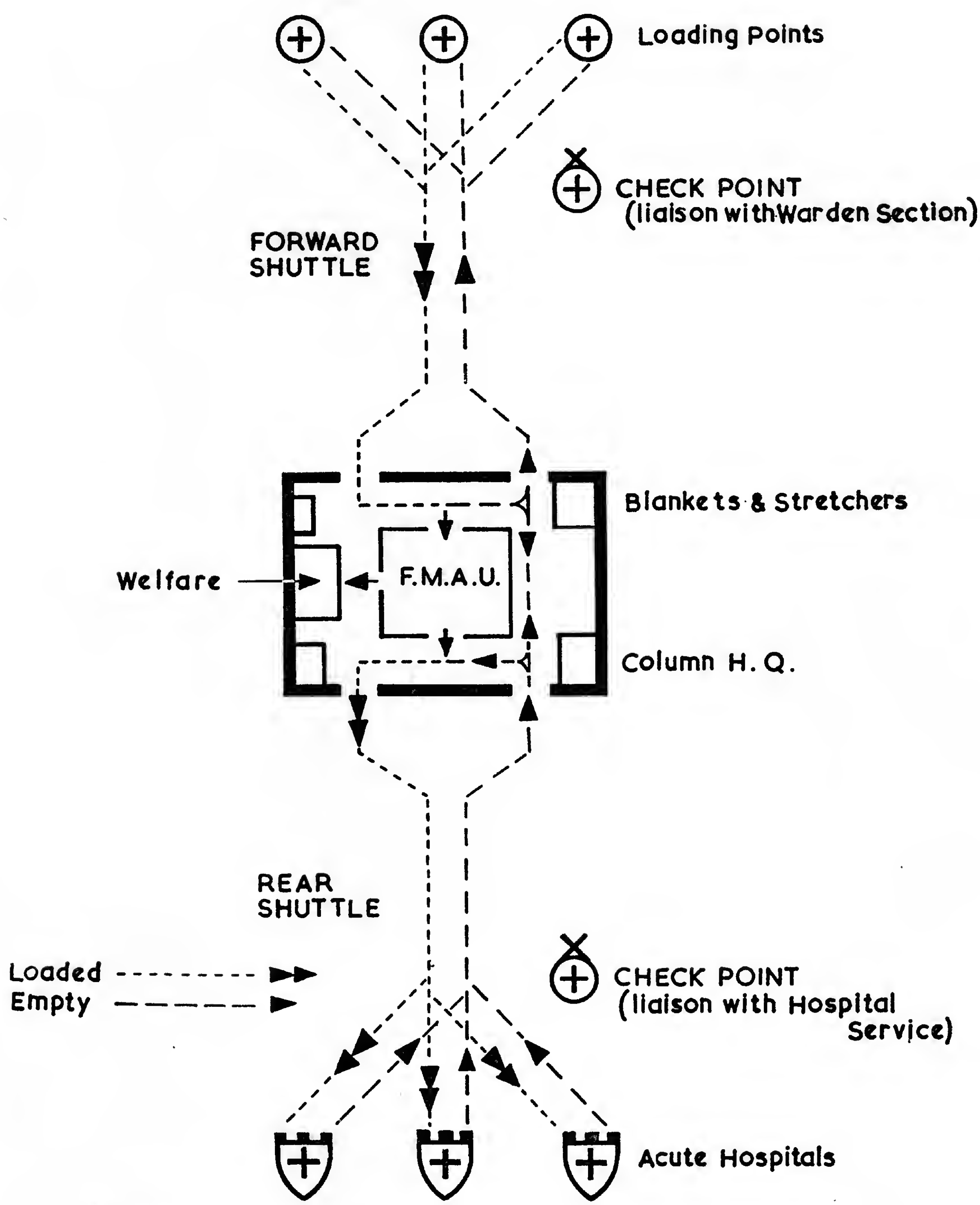
EIGHTPENCE NET

THE ORGANISATION OF AN AMBULANCE COLUMN

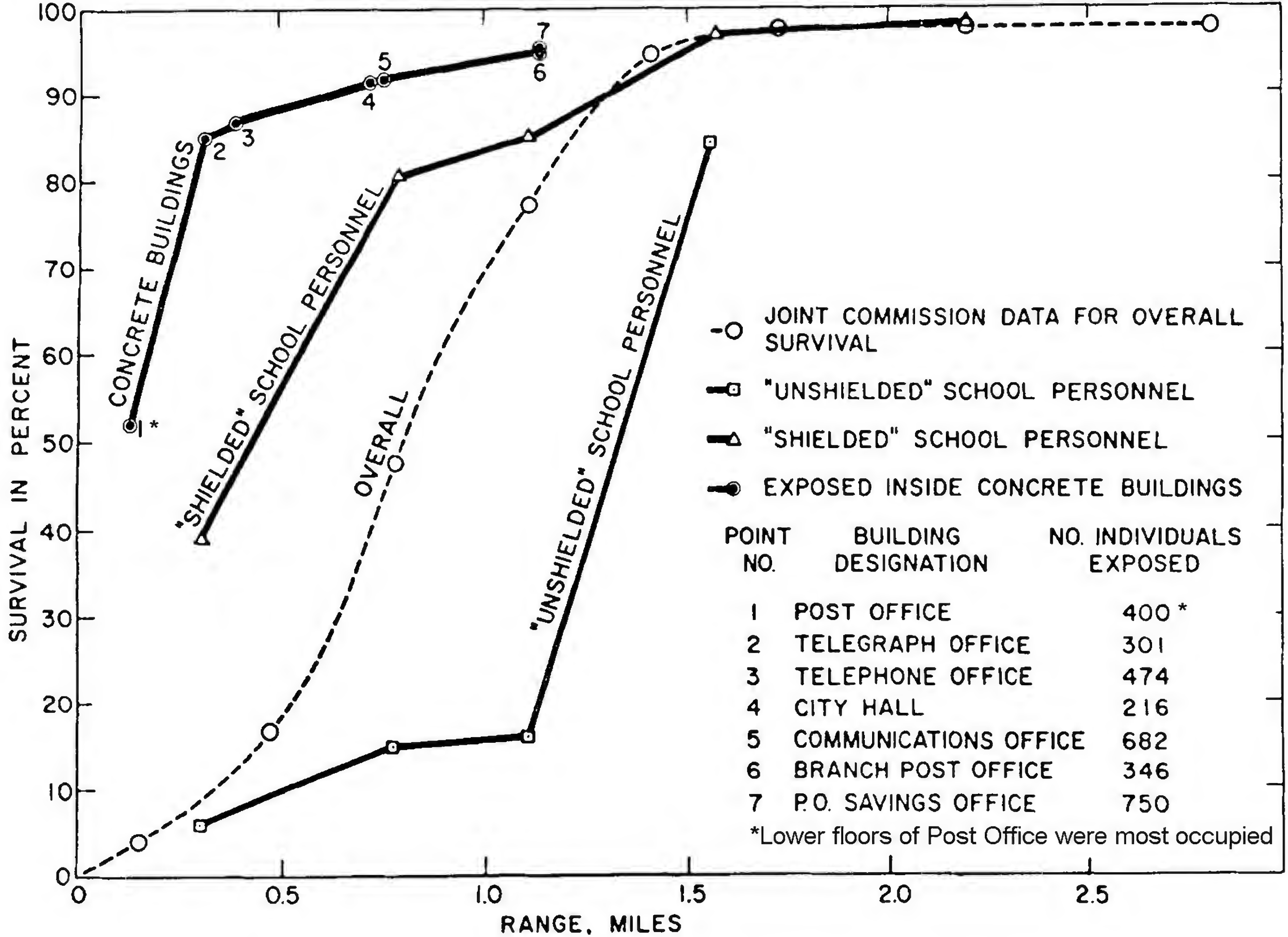
Appointment	*In charge of*	*Composition*	
		Personnel	*Vehicles*
Column Ambulance Officer Deputy Column Ambulance Officer	Ambulance Column comprising one Ambulance Company and one First Aid Company	334 (including drivers for staff cars and D.Rs.)	72 Ambulances 18 Personnel and Equipment Vehicles 10 Staff cars 10 Motor cycles
Company Ambulance Officer Deputy Company Ambulance Officer	Ambulance Company comprising four Ambulance platoons	187 (including drivers for staff cars and D.Rs.)	72 Ambulances 5 Staff cars 4 Motor cycles
Company First Aid Officer Deputy Company First Aid Officer	First Aid Company comprising three First Aid platoons	141 (including drivers for staff cars and D.Rs.)	18 Personnel and Equipment Vehicles 4 Staff cars 3 Motor cycles
Platoon Ambulance Officer Deputy Platoon Ambulance Officer	Ambulance platoon comprising three Ambulance detachments	45 (including driver for staff car)	18 Ambulances 1 Staff car
Platoon First Aid Officer Deputy Platoon First Aid Officer	First Aid platoon comprising six First Aid Parties	45 (including driver for staff car)	6 Personnel and Equipment Vehicles 1 Staff car
Ambulance Detachment Leader Deputy Ambulance Detachment Leader	Ambulance detachment	14	6 Ambulances
First Aid Party Leader Deputy First Aid Party Leader	First Aid party	7 (including driver)	1 Personnel and Equipment Vehicle

Note: Personnel and Equipment Vehicles (PEVs) Staff cars and motor cycles will not be issued for training purposes.

THE MOVEMENT OF AMBULANCES



F.M.A.U. = FORWARD MEDICAL AID UNIT (TRAINED TO APPLY PLASTER OF PARIS TO BROKEN LIMBS, ETC.)



Percentage of survivors as a function of range from Ground Zero (Hiroshima). (Ref. Joint Commission Report, Vol. VI, Document NP-3041.)

In Hiroshima, only 0.9% (17 burns) of 1,881 burns were due to ignited clothing, and only 0.7% (15 burns) were due to burns by firestorm flames!

TABLE 8.3A

Number of Persons with Burns from Different Causes (Tokyo Imperial University's First Survey, October–November 1945)

Distance from Hypocenter (km)	Secondary Burns† From Clothes on Fire	Secondary Burns† By Flame	Total Burns
0.6–1.0	3 (3.3)		89
1.1–1.5		1 (1.1)	327
1.6–2.0	4 (0.5)	4 (1.2)	717
2.1–2.5		6 (0.8)	558
2.6–3.0	5 (0.8)	3 (0.5)	140
3.1–3.5	4 (2.8)	1 (0.7)	41
3.6–4.0	1 (2.4)		4
Total	17 (0.9)	15 (0.7)	1,881

* Primary burns are burns by thermal rays from the A-bomb.
† Secondary burns are burns by fire other than thermal rays.
‡ Figures in parentheses are percentages of incidence.
Source: T. Kajitani and S. Hatano, "Medical survey on acute effects of atomic bomb in Hiroshima," in CRIABC vol. I, p. 522.

Note: there were 5 burns cases within 0.6 km, all primary

TABLE 8.3B

Region of Burns

	Head		Face		Neck		Total	
	Outdoors	Indoors	Outdoors	Indoors	Outdoors	Indoors	Outdoors	Indoors
Number of persons	179 (11.7)*	44 (12.3)	1,030 (67.4)	127 (35.7)	643 (42.1)	78 (21.9)	1,526	355
Total	223 (11.8)		1,157 (61.5)		721 (38.3)		1,881	

* Figures in parentheses are percentages of incidence.
Source: T. Kajitani and S. Hatano, "Medical survey on acute effects of atomic bomb in Hiroshima," in CRIABC vol. I, p. 522.

Above: extract from "Hiroshima and Nagasaki: The Physical, Social and Medical Effects", 1981 by the Japanese Committee for the Compilation of Materials on Damage Caused by Atomic Bombs

SURVIVAL IN WOODEN AND CONCRETE BUILDINGS, HIROSHIMA

TABLE 7.3

Casualties among the Groups Exposed to the Atomic Bomb inside Wooden Houses, Hiroshima

Name of Building	Structure	Distance and Direction from Hypocenter (km)	Number Exposed	Mortality Rate (%)
Lodging for an itinerant theatrical troupe	Two-story	0.7 E	17	100.0
Second Hiroshima Army Hospital	Single-story	1.0 N	402	75.3

Source: Science Council of Japan, *Genshibakudan Saigai Chōsa Hōkokusho* [SRIABC] (Tokyo: Nihon Gakujutsu Shinkōkai, 1951), p. 25.

TABLE 7.4

Casualties among the Groups Exposed to the Atomic Bomb inside Concrete Buildings, Hiroshima

Name of Building	Structure	Direction and Distance from Hypocenter (km)	Number Exposed	Mortality Rate (%)
The Bank of Japan, Hiroshima Branch	three-story	0.4 SE	75	57.3
Broadcasting Station	two-story	1.0 E	31	6.5
Communication Bureau	four-story	1.4 N	245	6.1
Japan Red Cross Hospital, Hiroshima	three-story	2.0 S	480	0.4

* While the total number of exposed is known, it has not been possible to determine how many died instantly or soon after the explosion.
Source: Science Council of Japan, *Genshibakudan Saigai Chōsa Hōkokusho* [SRIABC] (Tokyo: Nihon Gakujutsu Shinkōkai, 1951), p. 26.

Above: extract from "Hiroshima and Nagasaki: The Physical, Social and Medical Effects", 1981

18th April, 1950.

Sir,

Civil Defence Act, 1948
Regulations relating to the Evacuation of the
Civil Population (Statutory Instrument 1949, No.2147)

1. I am directed to refer to Circular 81/49 (Wales) of 23rd August, 1949, which transmitted for your information a copy of the draft Civil Defence (Evacuation and Care of the Homeless) Regulations, 1949. These Regulations have now been approved by both Houses of Parliament and are now operative. I am now to enclose a copy of a Memorandum on Evacuation (Memo Ev.1 (1950) which contains an outline of the general plan for the transfer of certain sections of the civilian population from the more densely populated areas in the event of war or the imminence of war. For the purpose of this transfer the system developed in the 1939/45 war has been adopted, whereby the country is divided into evacuation, neutral and reception areas

9. ESTIMATES OF ACCOMMODATION IN RECEPTION AREAS

In order that specific allocations may be worked out and each Reception Authority informed of the number of members of the priority classes for whom their plans should provide, it is requested that every Reception Authority will prepare an estimate of the total number of habitable rooms in their area. The Minister of Health has been advised by the Associations of Local Authorities that the Receptio Authorities (who are the Housing Authorities) will be able to make reasonably accurat estimates from information already available to them. The estimate should include all rooms normally used in the locality either as living rooms or as bedrooms. I am to ask that this estimate may be forwarded to the Department, not later than 30th June, 1950.

10. The Department do not consider that any useful purpose would be served by carrying out at this stage a detailed survey of the accommodation which could be made available for evacuees such as was undertaken in January, 1939.

IV. LATER ACTION

11. When the specific allocations of the number of members of the priority classes for whose reception arrangements should be made in each reception area have been decided, it will be possible to link each Reception Authority with a particular Evacuation Authority. When the plan has been developed in this way, or as the

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14. The Memorandum on Evacuation (Memo Ev.1 (1950) has been placed on sale. Further copies may be purchased direct from His Majesty's Stationery Office or from any bookseller.

I am, Sir,
Your obedient Servant,

William Thomas

The Clerk of the Council.

LINKING OF EVACUATION AND RECEPTION AREAS FOR ORGANISED EVACUATION

MERSEYSIDE GROUP

EVACUATION AREAS

Liverpool C.B.	Bebington B.
Birkenhead C.B.	Widnes B.
Wallasey C.B.	Litherland U.D.
Bootle C.B.	Northwich U.D.
Crosby B.	Runcorn U.D.
	Ellesmere Port U.D.

Estimated Civil Population, 1,320,000 *

Estimated number of members of priority classes, 376,300

ASSOCIATED RECEPTION AREAS

County	Local Authority	Estimated Civil Population *
Cheshire	Chester C.B.	48,000
	Alsager U.D.	5,000
	Hoole U.D.	9,000
	Hoylake U.D.	26,000
	Middlewich U.D.	6,000
	Nantwich U.D.	9,000
	Neston U.D.	9,000
	Sandbach U.D.	9,000
	Winsford U.D.	12,000
	Wirral U.D.	17,000
	Chester R.D.	19,000
	Nantwich R.D.	26,000
	Tarvin R.D.	15,000
	Total	210,000
Lancashire	Blackpool C.B.	152,000
	Southport C.B.	84,000
	Colne B.	20,000
	Fleetwood B.	26,000
	Nelson B.	34,000
	Adlington U.D.	4,000
	Barrowford U.D.	5,000
	Brierfield U.D.	7,000
	Formby U.D.	9,000
	Kirkham U.D.	4,000
	Ormskirk U.D.	21,000
	Padiham U.D.	10,000
	Poulton le Fylde U.D.	8,000
	Preesall U.D.	2,000
	Skelmersdale U.D.	6,000

* Registrar-General's estimate of civil population as at mid-1948.

DS 25404/1(17)

ASSOCIATED RECEPTION AREAS (Contd.)

County	Local Authority	Estimated Civil Population *
Cardigan	Aberystwyth B.	10,000
	Cardigan B.	3,000
	Lampeter B.	2,000
	Aberayron U.D.	1,000
	New Quay U.D.	1,000
	Aberayron R.D.	9,000
	Aberystwyth R.D.	10,000
	Teifiside R.D.	10,000
	Tregaron R.D.	5,000
	Total	51,000
Denbigh	Colwyn Bay B.	23,000
	Denbigh B.	8,000
	Ruthin B.	4,000
	Wrexham B.	29,000
	Abergele U.D.	7,000
	Llangollen U.D.	3,000
	Llanrwst U.D.	3,000
	Aled R.D.	7,000
	Ceiriog R.D.	7,000
	Hiraethog R.D.	5,000
	Ruthin R.D.	10,000
	Wrexham R.D.	62,000
	Total	168,000
Flint	Flint B.	14,000
	Buckley U.D.	8,000
	Connah's Quay U.D.	7,000
	Holywell U.D.	8,000
	Mold U.D.	6,000
	Prestatyn U.D.	8,000
	Rhyl R.D.	19,000
	Hawarden R.D.	32,000
	Holywell R.D.	22,000
	Overton R.D.	6,000
	St. Asaph R.D.	8,000
	Total	138,000
Merioneth	Bala U.D.	1,000
	Barmouth U.D.	2,000
	Dolgelley U.D.	2,000
	Festiniog U.D.	7,000
	Towyn U.D.	3,000
	Deudraeth R.D.	7,000
	Dolgelley R.D.	8,000
	Edeyrnion R.D.	4,000
	Penllyn R.D.	3,000
	Total	37,000

[redacted]

TM 23-200/OPNAV INSTRUCTION 03400.1C/AFM 136-1/FMFM 11-2

THIS PUBLICATION SUPERSEDES TM 23-200, OPNAV INSTRUCTION 03400.1B, AFM 136-1/NAVMC 1104 REV, NOVEMBER 1957, INCLUDING CHANGE 1, 24 JUNE 1960 AND CHANGE 2, 3 OCTOBER 1960 THERETO.

105483

R

CAPABILITIES OF NUCLEAR WEAPONS [U]

United States Government Printing Office
Washington: 1964

[redacted]

GROUP-3
Downgraded at 12 year intervals;
Not automatically declassified.

Table 7-1 Estimated Casualty Production in Structures for Various Degrees of Structural Damage

Structural damage	Killed outright	Serious injury (hospitalization)	Light injury (No hospitalization)
		Percent*	
1-2 story brick homes (high explosive data):			
Severe damage	25	20	10
Moderate damage	<5	10	5
Light damage		<5	<5
Reinforced-concrete buildings (Japanese data, nuclear):			
Severe damage	100		
Moderate damage	10	15	20
Light damage	<5	<5	15

*These percentages do not include the casualties that may result from fires, asphyxiation, and other causes from failure to extricate trapped personnel. The numbers represent the estimated percentage of casualties expected at the maximum range where the specified structural damage occurs. For the distances at which these degrees of damage occur for various yields see Chapter 8.

example, although such effects as capacitor discharge are usually referred to as transient effects, the time constant for recovery of the capacitor to its normal operating potential may be so long that recovery may not be effected before the mission of the system involved is complete. In this instance the effect would be classified as permanent damage even though the capacitor itself would have eventually completely recovered.

ELECTROMAGNETIC PULSE RADIATION DAMAGE

a. General. Permanent damage due to overheating or puncturing of insulation is possible where the electromagnetic pulse energy is high, where the induced voltage triggers an electrical fault and the damage energy is supplied by the affected system, or where the electromagnetic pulse energy is carried for some distance along a cable or line as a power surge.

Interruption of service may occur where the voltage induced in a cable or line causes fuses to blow or circuit breakers to trip. This may take place many miles away from the point of detonation due to transmission of the surge. An interruption could also result if an electronically stored program were subjected to a strong enough transient electromagnetic field to scramble it.

Transient disturbances to electronic systems may occur in several ways. The electromagnetic pulse may be received via the signal or power lines acting as antennae. Or, the low frequency portion of the pulse may penetrate the enclosures and directly induce transient signals in the circuits.

Many instances of all three kinds of damage, i.e., permanent, interruptive and transient, have been experienced. So far, little if any, correlation of damage with measured electromagnetic field strengths has been established. This has been the result of factors previously described, and of uncertainty of the point where electromagnetic pulse pickup actually occurred in cases where many cables and lines were in use for power, signal, control and mechanical purposes.

b. Power System Damage. Very regular zero-time tripping of power circuit breakers at a substation more than 30 miles away was observed on one series of tests. Standby personnel were always posted to reset the breakers to keep electrical equipment functioning. Within a mile of ground zero, pinholes in underground cable insulation have frequently been found. Such cables carried up to 4160 volts.

At power distribution stations, porcelain cutouts have been observed to arc over and the fuses have often blown. At other stations power transformers have been shorted internally or have had insulating bushings destroyed. Ordinary lightning protective devices provided inadequate protection against the electromagnetic pulse, in those cases.

c. Signal System Damage. Damage to signal systems has also been frequent in the form of burned or fused relays, potentiometers, cable insulation and conductors, as well as blown or damaged meters. In many instances, reviews of the circuits have shown that induced energy caused the damage, rather than triggered system energy. Free ends of cable pairs have often arced and melted.

d. Electronic System Damage. Oscilloscope presentations have frequently been disturbed or obliterated, even as far as 11 miles from ground zero.

Pulse counters in a timing circuit have been scrambled directly by the induced field (this effect has actually been duplicated in a simulation test in which a 1 mfd capacitor was charged to several thousand volts, then discharged into 10 turns of wire wound around the cabinet). Memory circuits employing magnetic elements may be vulnerable to the magnetic field, H, in a direct manner, as well as to the time derivative of the field.

Elaborate protective measures against electromagnetic effects have been devised, on occasion, such as extensive grounding plate systems, double-walled screen rooms, precautions against forming loops, and special bonding. These measures appeared effective on certain occasions, but on others, when higher yield weapons were tested, the precautions did not always suffice.

General recommendations for protection against electromagnetic pulse radiation damage cannot yet be made. Protective measures to be taken will depend principally upon the nature of the target and the degree of protection required.

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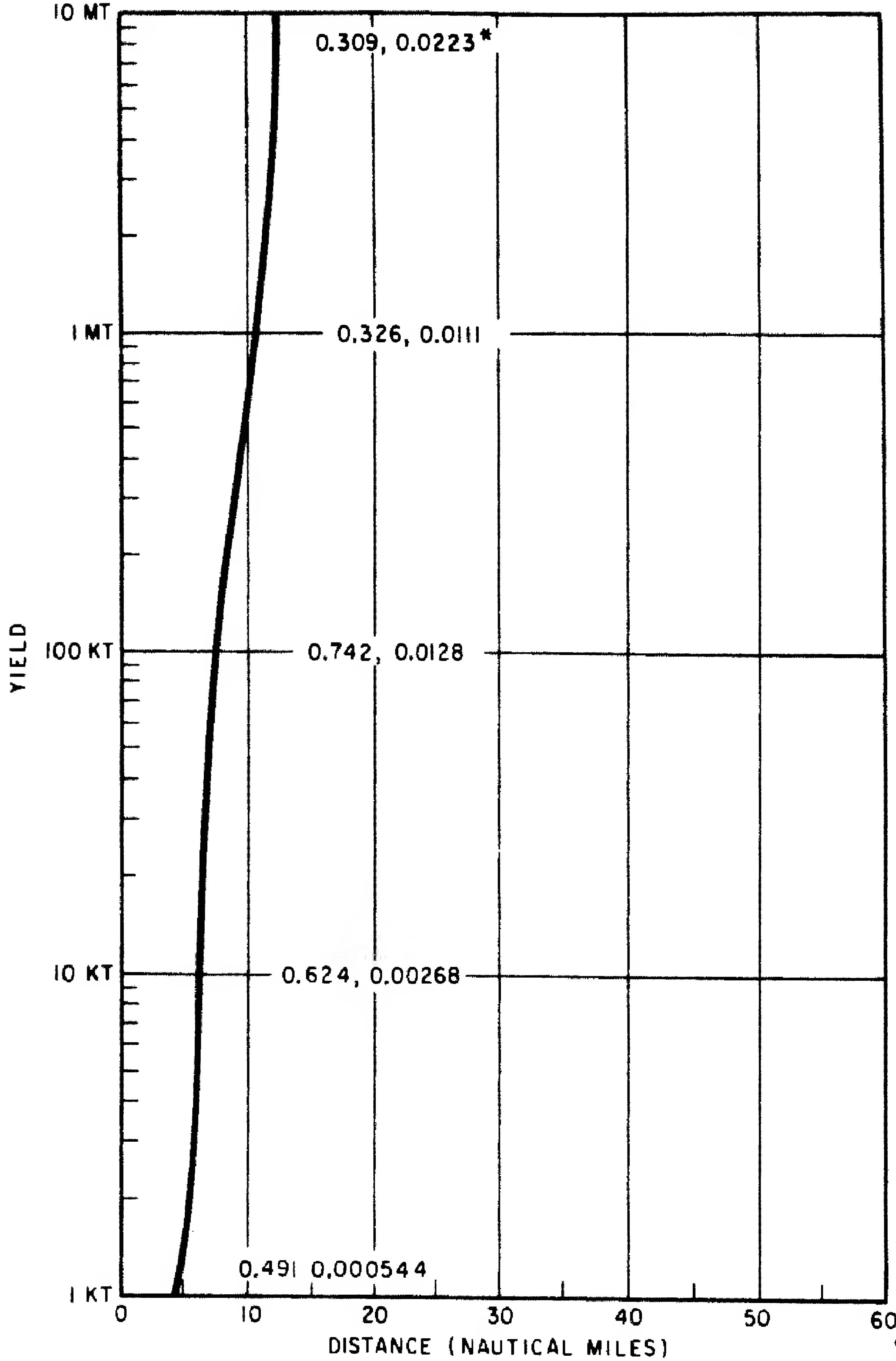


*EACH PAIR OF VALUES INDICATE, RESPECTIVELY, CALORIES AT THE CENTER OF THE IMAGE AND CALORIES ON THE LENS SURFACE

SEA LEVEL (BURST AND OBSERVER)
WATER VAPOR PRESSURE: 5mm HG
PUPILLARY DIAMETER: 3mm

Figure 7-3. Yield vs. Maximum Distance at which a Retinal Burn will be Formed. Visibility 10 Statute Miles; Standard Normal Day, and Daytime Adapted Eye

13-5 FIRE IN URBAN AREAS. The employment of an air burst weapon over urban areas may produce, besides blast damage, mass fires which, under proper conditions, materially increase the degree and extent of damage. The behavior of such fires, whether they are of primary or secondary origin, follows the pattern of fires in forest and wildland areas. The burning potential for urban areas varies with weather conditions, much as for wildlands; however, the fire season as such is not as pronounced as in wildlands. During those seasons when weather conditions may reduce exterior potentials to zero, dwellings are usually heated, so that interior fuels are dried out. Fire incidence and subsequent fire buildup depend also upon the amount and distribution of flammable material used in interior furnishing and building construction, the incidence of interior kindling fuels, and the relative cleanliness of the living habits of the population.

13-6 Ignition Points. A survey of metropolitan areas in the United States indicates that the incidence of exterior ignition points can be correlated with urban land use. Table 13-1 presents a relative tabulation based on exterior kindling fuels. Newspapers and other paper products account for 70 percent of the total, and dry grass and leaves account for another 10 percent in residential areas. Most other exterior kindling fuels are present in small percentages or require radiant exposures in excess of 10 cal/cm^2 for ignition. Weathered and badly checked fences and building exteriors that contain appreciable dry rot constitute an ignition hazard. The tabulation presented in table 13-1 is not representative of European cities and other areas where fuel is at a premium, or where extensive use is made of stone, brick, masonry, and heavy timber construction. Multistory buildings and narrow streets reduce both interior and exterior primary ignitions, because such ignitions are proportional to the amount of sky seen from the location of the probable ignition point.

13-7 Humidity Effects. Because paper is the major exterior kindling fuel and is also an important interior fuel, the extent of ignitions may be estimated from the minimum radiant exposure requirements for newspaper. Figure 13-1 shows the radiant exposure required to ignite darkly printed picture areas and printed text areas of newspaper at 50% relative humidity. The effect of relative humidity on the ignition of this cellulosic fuel can be estimated by multiplying the ignition radiant exposures for the dry material by the factor, $1 + 0.005\,H$, where H is the relative humidity in percent. Maximum fire effects occur during daily periods of lowest relative humidity, usually mid-afternoon. Guides for estimating urban burning potentials are given in figures 13-2 and 13-3. Figure 13-2, which gives burning potential for urban areas when central heating is not in use, represents approximate values of wind speed and average daytime relative humidity conditions corresponding to low, dangerous, and critical burning potentials according to the following definitions:

Table 13-1 Relative Incidence of Ignitions in Metropolitan Areas of the United States by Land Use (Based on Exterior Kindling Fuels).

Land use	Relative incidence
Downtown retail	1.0
Large manufacturing*	1.4
Good residential	1.6
Small manufacturing	3.8
Poor residential	5.2
Neighborhood retail	5.5
Waterfront areas	8.0
Slum residential	11.7
Wholesaler	15.1

* May be likened to a typical fixed military installation in the Z.1.

Low. Slow burning fires; fire can be controlled at will. Control action can be on unit structure basis.

Dangerous. Fires burn rapidly; individual building fires combine to form an area fire. Organized action needed to confine fire to area originally ignited.

[redacted]

Table 13-2 Critical Radiant Exposures for Damage to Various Materials

ambient relative humidity of 65 percent

Material	Weight (oz/sq yd)	Color	Effect on Material	Radiant Exposure (cal/cm^2) 40 kt	1 mt	10 mt
Clothing Fabrics						
Cotton	8	White	Ignites	32	48	85
		Khaki	Tears on flexing	17	27	34
			Ignites	20	30	39
		Olive	Tears on flexing	9	14	21
			Ignites	14	19	21
		Dark Blue	Tears on flexing	11	14	17
			Ignites	14	19	21
Cotton-nylon Mixture	5	Olive	Tears on flexing	8	15	17
			Ignites	12	28	53
Wool	8	White	Tears on flexing	14	25	38
		Khaki	Tears on flexing	14	24	34
		Olive	Tears on flexing	9	13	19
		Dark Blue	Tears on flexing	8	12	18
	20	Dark Blue	Tears on flexing	14	20	26
Rainwear (double neo-prene coated nylon twill)	9	Olive	Begins to melt	5	9	13
			Tears on flexing	8	14	22
Tinder Materials						
Paper, bond, typing, new (white)			Ignites	24	30	50
Newspaper, printed text			Ignites	6	8	15
Newsprint, dark picture area			Ignites	5	7	12
Paper, kraft, single sheet (tan)			Ignites	10	13	20
Rags (black, cotton)			Ignites	10	15	20
Rags (black, rayon)			Ignites	9	14	21
Tent Material						
Canvas, white, 12 oz/sq yd			Ignites	13	28	51
Canvas, OD, 12 oz/sq yd			Ignites	12	18	28
Aluminum aircraft Skin (0.020 in. thick) coated with 0.002 in. of standard white aircraft paint			Blisters	15	30	40
Sandbags, cotton, canvas, dry, filled			Failure	10	18	32
Construction Materials						
Roll Roofing, mineral surface			Ignites	—	>34	>116
Roll Roofing, smooth surface			Ignites	—	30	77
Plywood, douglas fir			Flaming during exposure	9	16	20
Sand, coral			Explosion*	15	27	47
Sand, siliceous			Explosion*	11	19	35
Rubber, pale latex			Ignites	50	80	110
Rubber, black			Ignites	10	20	25

* Popcorning

 [redacted]

Table 7-2 Radiant Exposures for Burns Under Clothing

Clothing	Burn	40 kt	1 mt	10 mt
		Radiant exposures[1,2]		
Bare skin	none	2.0	2.6	2.9
	1°	2.6	3.1	3.5
	2°	4.6	6.3	7.0
Summer uniform (2 layers of light porous fabric)	none	5	6	7
	1°	10	16	21
	2°	12	20	26
Winter uniform (2 to 5 layers of tightly woven fabric)	none	7	10	12
	1°	13	21	29
	2°	16	26	36
Sub-artic and arctic (3 to 8 layers of tightly woven fabric)[3]	none	15	25	40
	1°	15	25	40
	2°	15	25	40

[1] Expressed in cal/cm^2 incident on skin or outer surface of clothing when the inner layer of the clothing is spaced 0.5 cm from the skin and when at least the first 70% of the thermal pulse is received normal to the surface.

[2] These values are sensitively dependent on many variables and are probably correct to within ±50% for the range of normal military situations.

[3] Burns to personnel wearing these heavy uniforms will occur only by contact with flaming or glowing outer garments. Some systems require in excess of 100 cal/cm^2 to produce burns by direct transmission of heat through the fabrics.

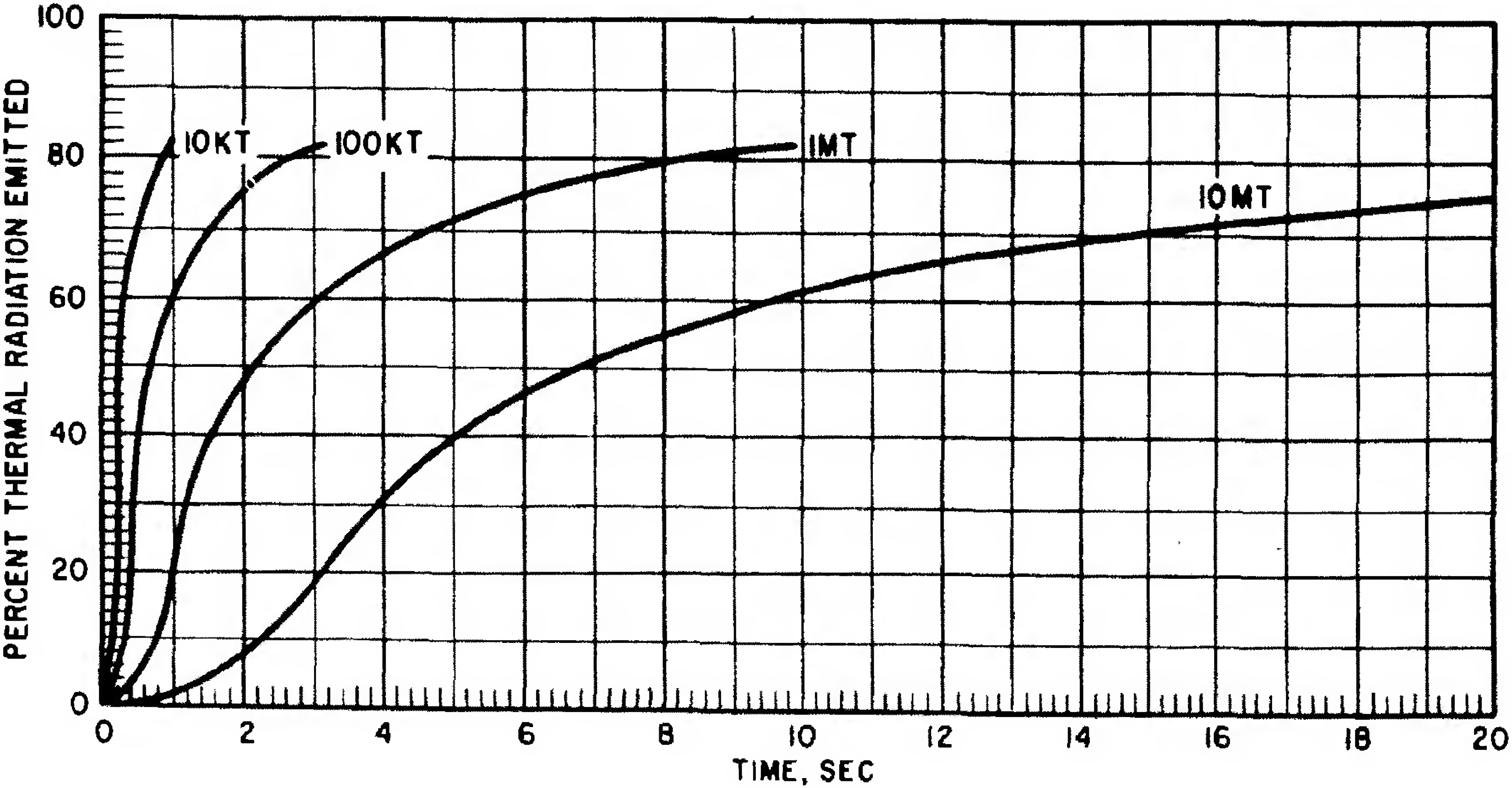


Figure 7-2. Percent Thermal Radiation Emitted vs. Time for Detonations Within the Atmosphere

Teapot-MET (1955)

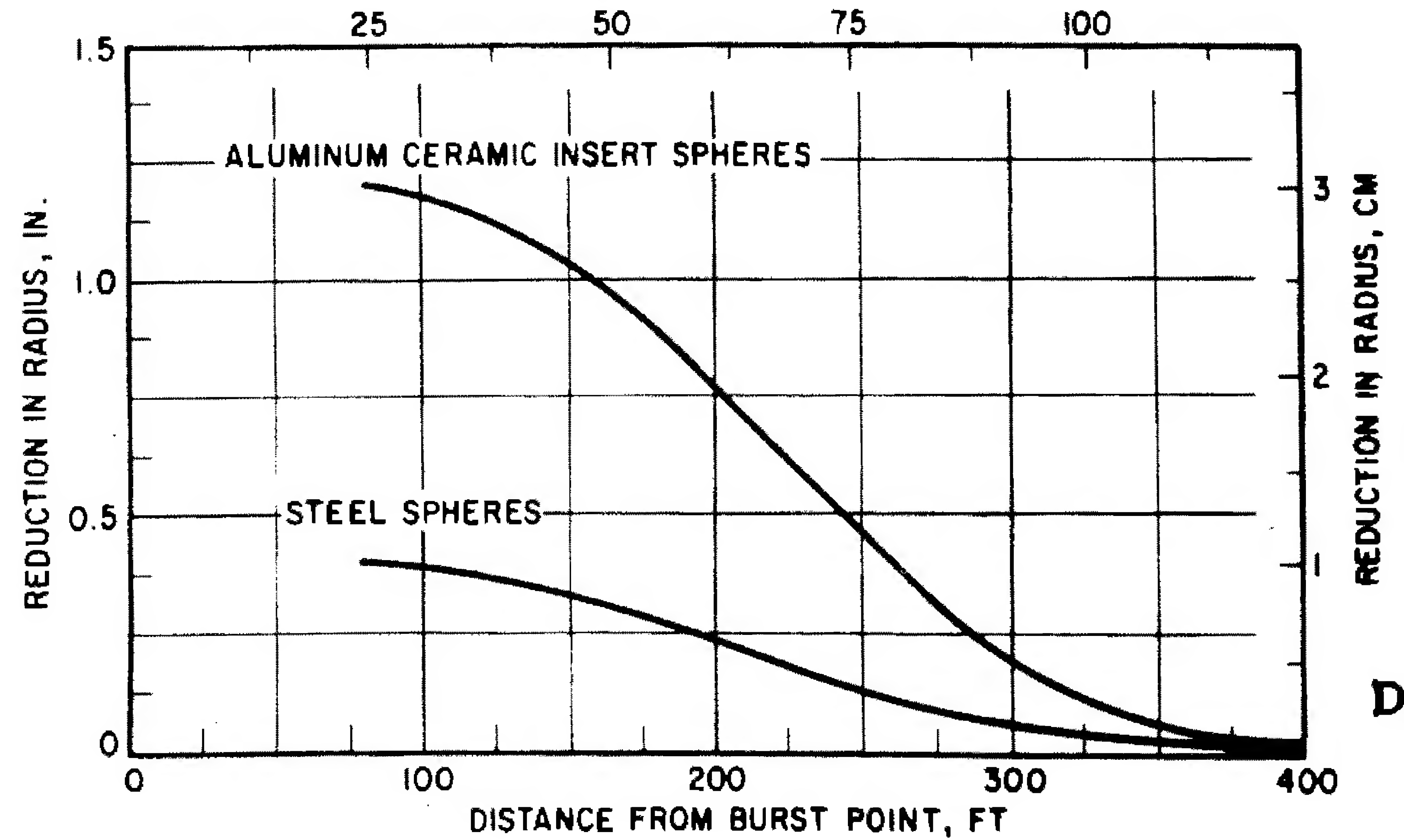


Figure 13-5. Reduction of Sphere Radius with Distance from a 23-kt Burst for Aluminum, Steel, and Ceramic Insert Spheres

Table 7-4 Summary of Clinical Effects of Acute Ionizing Radiation Dose

		Therapeutic range			Lethal range	
		100-200 rems	200-600 rems	600-1000 rems	1000-5000 rems	Over 5000 rems
Range	Subclinical range	Clinical surveillance	Therapy effective	Therapy promising	Therapy palliative	
Incidence of vomiting	None	100 rems: 5% 200 rem:: 50%	300 rems: 100%	100%	Up to 100%	
Delay time	——	3 hours	2 hours	1 hour	30 minutes	
Leading organ	None	Hematopoietic tissue			Gastro-intestinal tract	Central nervous system
Characteristic signs	None	Moderate leukopenia	Severe leukopenia; purpura; hemorrhage; infection. Epilation above 300 rems.		Diarrhea; fever; disturbance of electrolyte balance	Convulsions; tremor; ataxia; lethargy
Critical period postexposure	——	——	4 to 6 weeks		5 to 14 days	1 to 48 hours
Therapy	Reassurance	Reassurance, hematologic surveillance	Blood transfusion; antibiotics	Consider bone marrow transplantation	Maintenance of electrolyte balance	Sedatives
Prognosis	Excellent	Excellent	Good	Guarded	Hopeless	
Convalescent period	None	Several weeks	1-12 months	Long		
Incidence of death	None	None	0-80% (variable)	80-100% (variable)	95-100%	
Death occurs within	——	——	2 months		2 weeks	2 days
Cause of death	——	——	Hemorrhage; infection		Circulatory collapse	Respiratory failure; brain edema

Table 7-5 Dose Transmission Factors (Interior Dose/Exterior Dose)

Geometry	*Gamma rays*		*Neutrons*[1]
	Initial	Residual	
Foxholes[2]	0.20	0.10	0.30
Underground—3 ft	0.04-0.05	0.0002	0.002-0.01
Builtup city area (in open)	—	0.70	—
Frame house	0.80	0.30-0.60	0.3-0.8
Basement	0.05-0.5	0.05-0.1	0.1-0.8
Multistory building:			
Upper	0.9	0.01	0.9-1.0
Lower	0.3-0.6	0.1	0.9-1.0
Blockhouse walls:			
9 in	0.1	0.007-0.09	0.3-0.5
12 in	0.05-0.09	0.001-0.03	0.2-0.4
24 in	0.01-0.03	0.0001-0.002	0.1-0.2
Factory, 200 x 200 ft	—	0.1-0.2	—
Shelter, partly above grade:			
With earth cover—2 ft	0.02-0.04	0.005-0.02	0.02-0.08
With earth cover—3 ft	0.01-0.02	0.001-0.005	0.01-0.05
Rough Terrain	—	0.4-0.8	—
Tanks: M-24, M-41, Tank Recov. Vehicle M-51, M-74	0.3-0.5	0.2	0.5-0.7
Tanks: M-26, M-47, M-48, T-43E1; Eng. Armd. Vehicles, T-39E2	0.2-0.4	0.1	0.3-0.6
Tractor, crawler, D8 w/blade	1.0	0.4	1.0
1/4-ton truck	1.0	0.8	1.0
3/4-ton truck	1.0	0.6	1.0
2-1/2-ton truck	1.0	0.5-0.6	1.0
Armd. Inf. Vehicle M-59, M-75, and 8P Twin 40mm Gun M-42	0.8-1.2	0.2-0.6	0.8-1.0
SP 105-mm howitzer M-52	0.6-0.8	0.4-0.6	0.8-1.0
Cruisers[3]			
Navigating Bridge	0.12-0.35	0.005-0.2	0.75
Superstructure Deck	0.008-0.25	0.0001-0.1	0.7
Main Deck	0.005-0.25	0.00003-0.1	0.7
Second Deck	0.0002-0.2	0-0.07	0.6
First Platform	0.0002-0.2	0-0.07	0.2-0.3
Second Platform	0.0001-0.10	0-0.01	0.05-0.15
Destroyer[3]			
Navigating Bridge	0.25-0.40	0.1-0.2	0.85
Superstructure Deck	0.015-0.40	0.00025-0.2	0.8-0.85
Main Deck	0.008-0.34	0.0001-0.2	0.75-0.8
First Platform	0.001-0.25	0-0.1	0.75-0.8
Second Platform	0.0005-0.20	0-0.07	0.5-0.75

[1] Estimated values.

[2] No line-of-sight radiation received.

[3] Assuming a beam-on orientation.

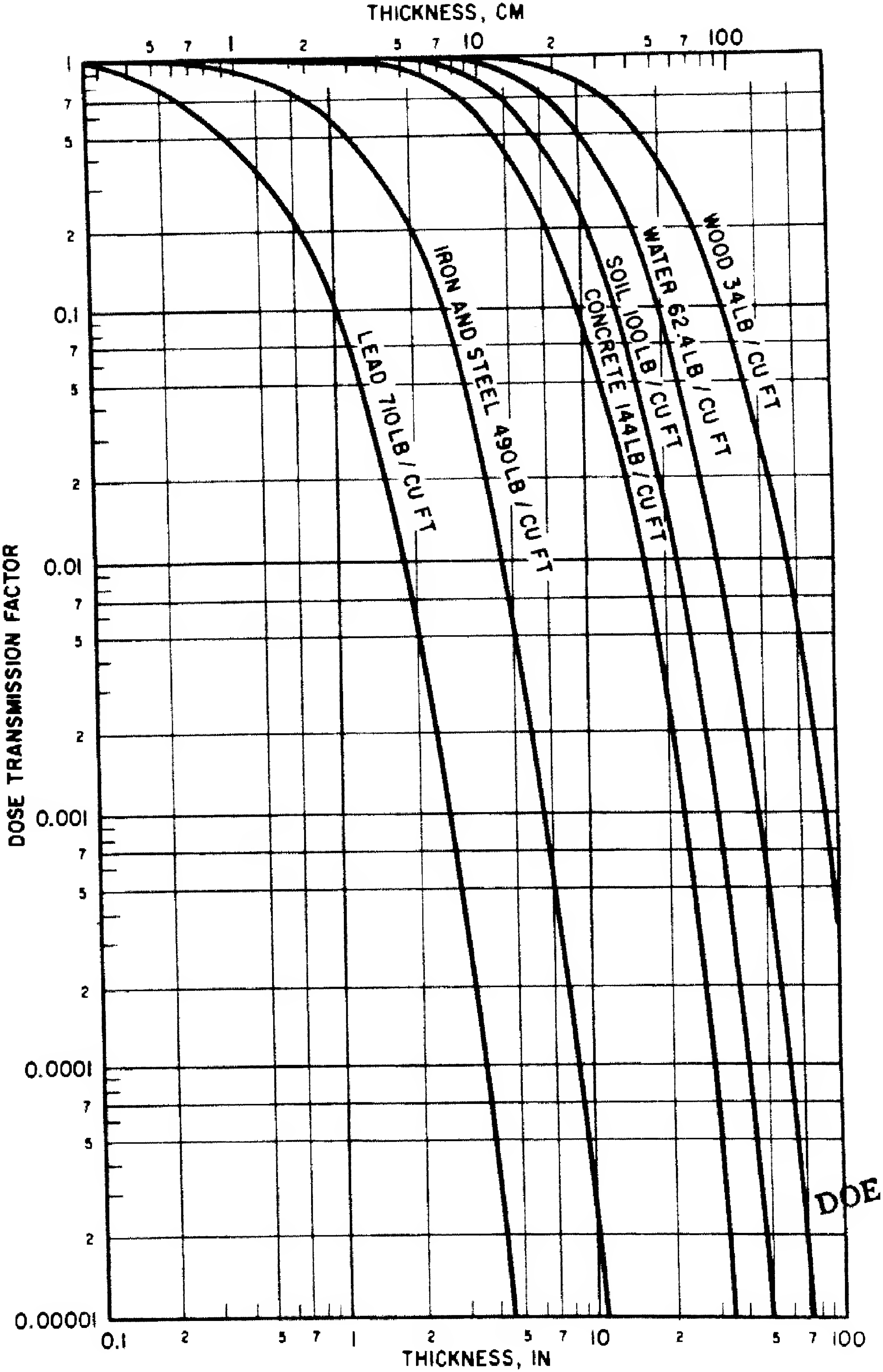


Figure 7-12. Shielding from Residual Gamma Radiation

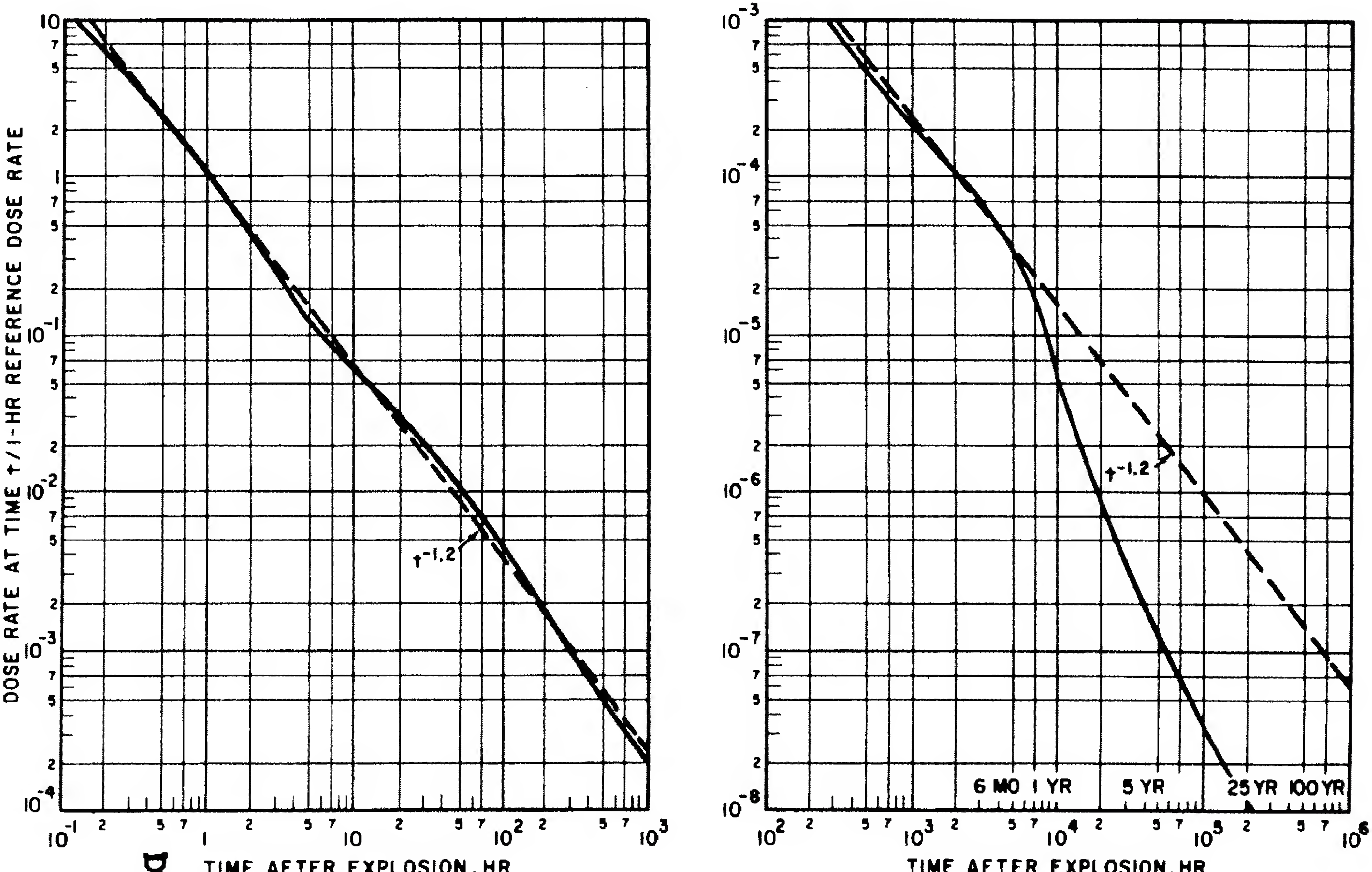


Figure 4-21. Fission-product Decay Factors Normalized to Unity, 1 hr after Detonation

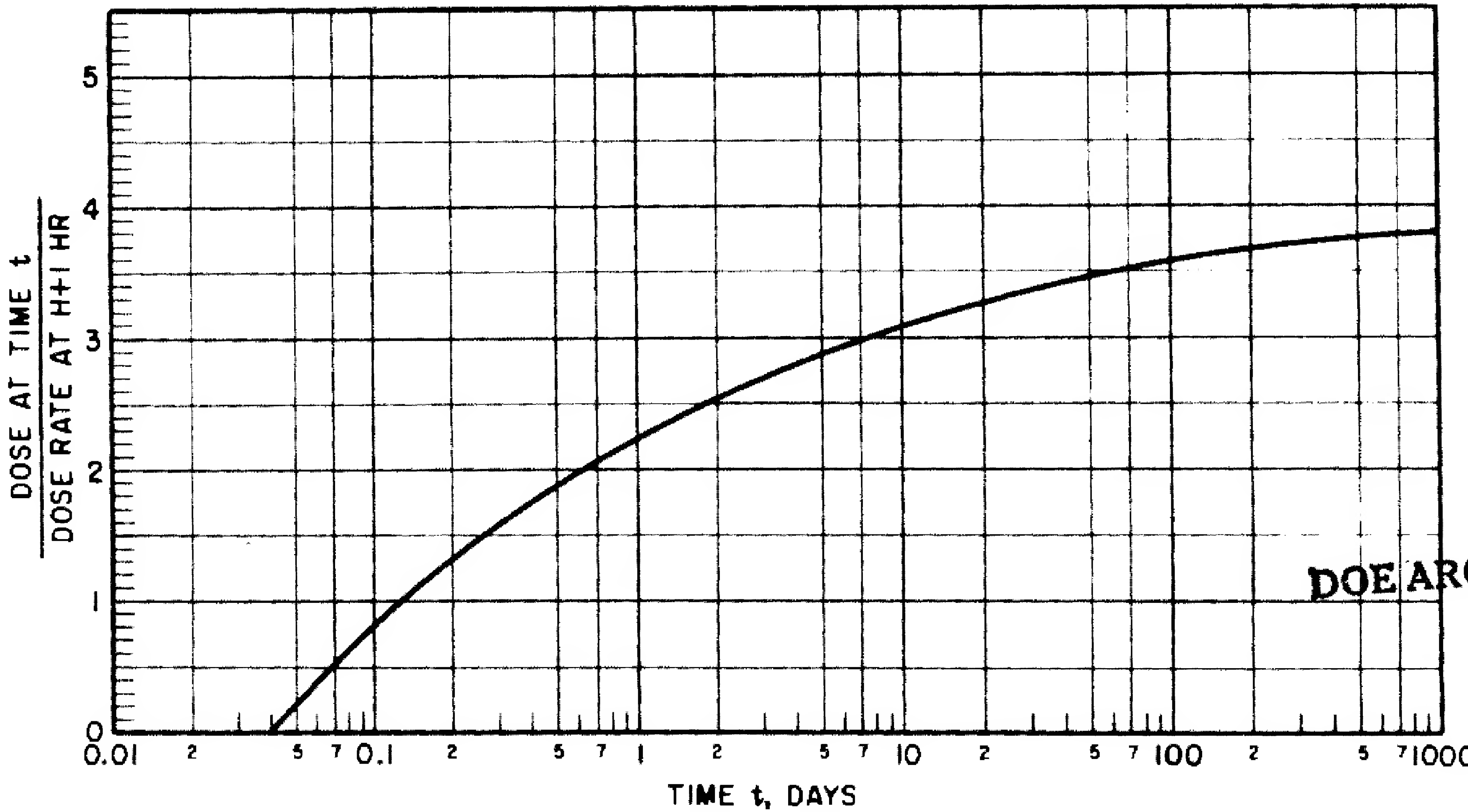


Figure 4-22. Normalized Theoretical Dose Accumulated in a Fallout-contaminated Area from $H + 1$ hr to $H + 1000$ Days

4-13 AIR BURST. The surface contamination effects of fallout from an air-burst weapon are militarily insignificant in most cases because the bomb cloud carries most of the radioactive bomb debris to high altitudes. In general, by the time this material can fall back to earth, dilution and radioactive decay decreases the activity to levels that are no longer militarily important. An exception may occur in the case of a small-yield weapon burst in the rain, where the scavenging effect of the precipitation may cause a rainout of radioactive material that will be hazardous to personnel located downwind and downhill, and outside the hazard area of initial radiation and other effects. Although the range of weapon yields for which rainout may become hazardous is not large, quantitative treatment of the problem is difficult. The contamination pattern on the ground depends upon the scavenging effect of precipitation on suspended fission products in the atmoshere, and the flow and ground absorption of rain water after reaching the ground.

Some of the factors that influence the scavenging effect are:

(1) Height and extent of the rain cloud
(2) Raindrop size and distribution
(3) Rate of rainfall
(4) Duration of precipitation
(5) Position of the nuclear cloud relative to the precipitation
(6) Hygroscopic character of the fission products
(7) Solubility of the fission products
(8) Size of the fission fragments

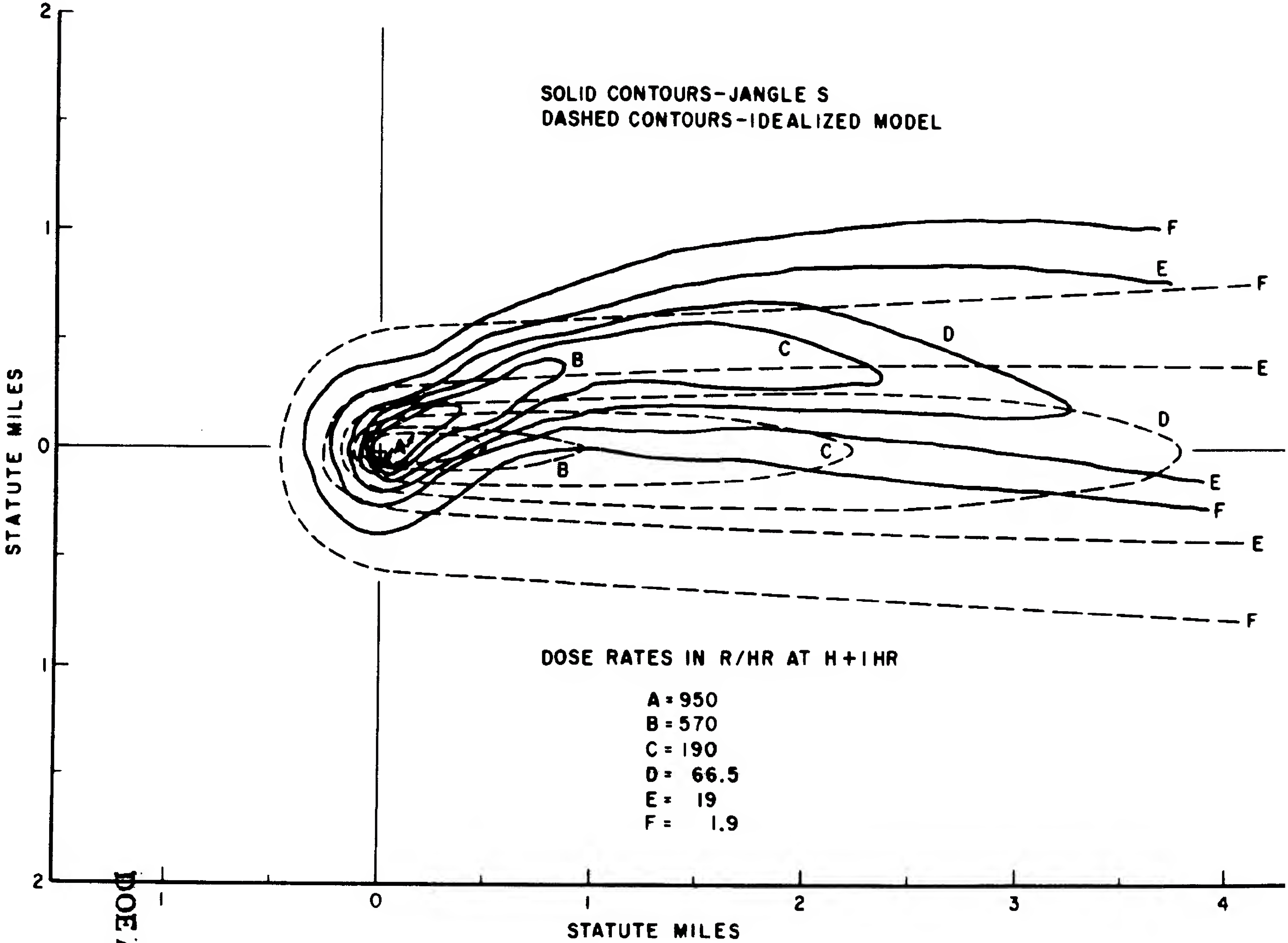


Figure 4-3. Comparison of Actual Fallout Contours with Idealized Model for a Yield of 1.2 kt and Effective Wind of 20 knots

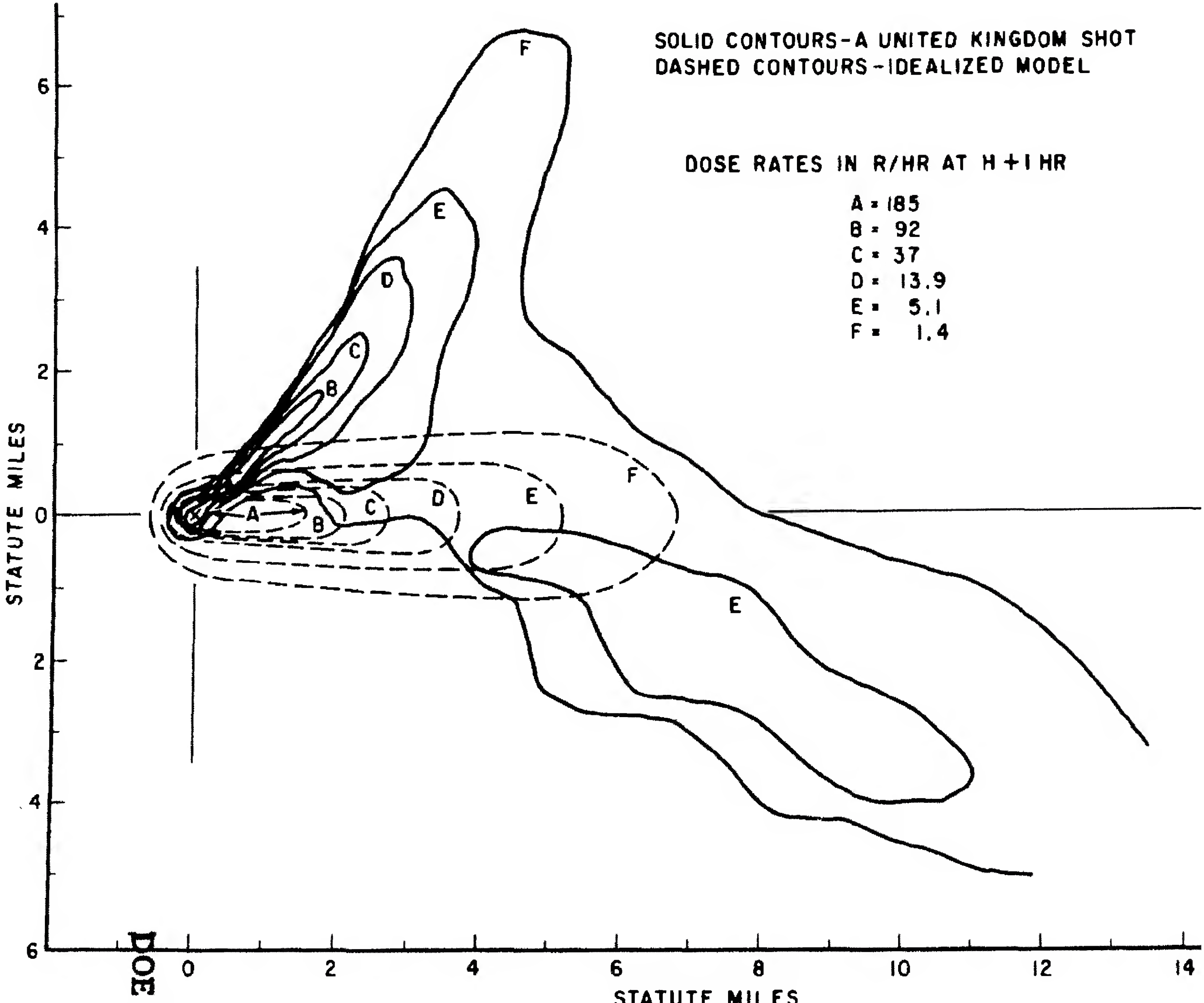


Figure 4-4. Comparison of Actual Fallout Contours with Idealized Model for a Yield of 1 kt and Effective Wind of 10 knots

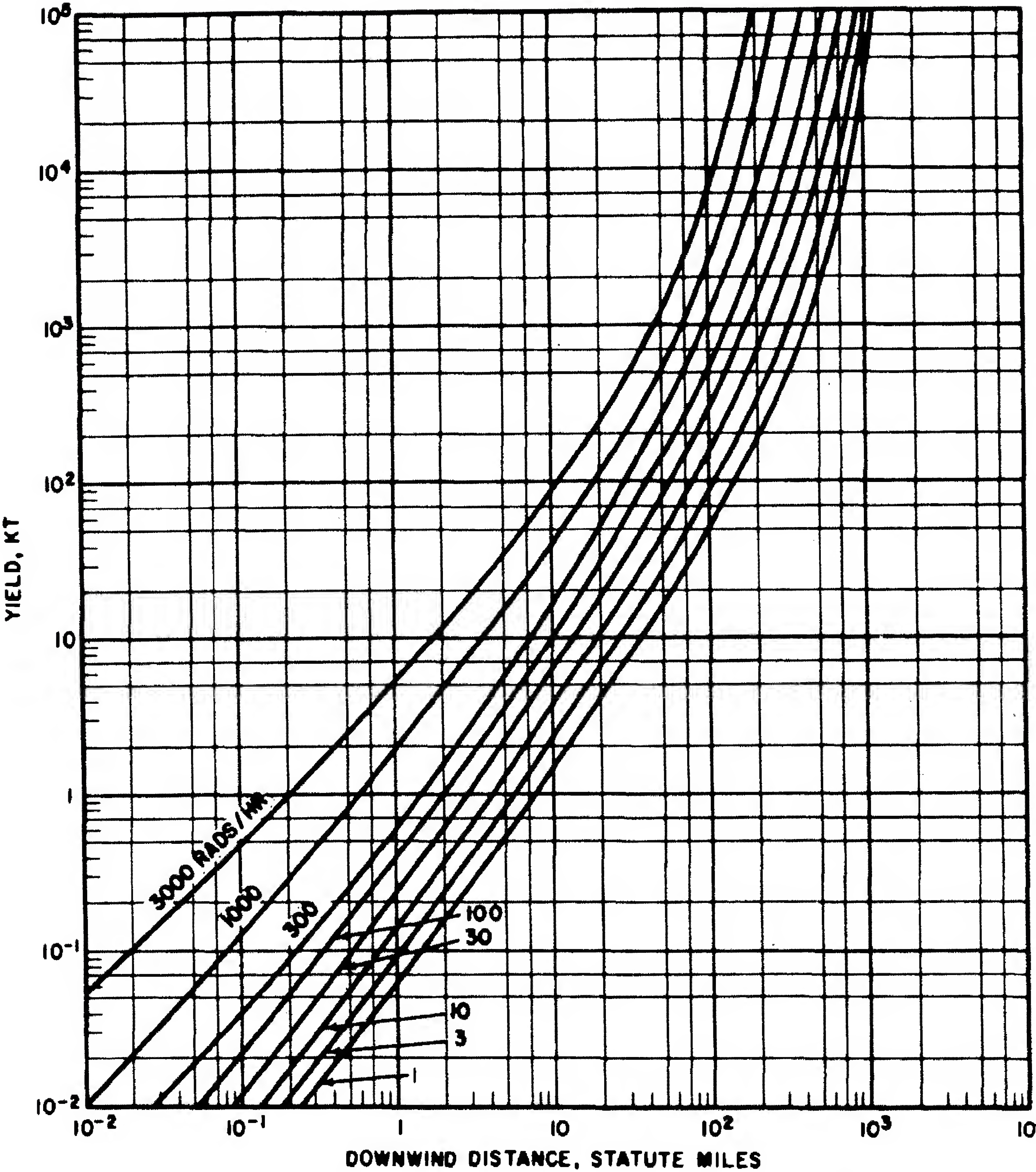
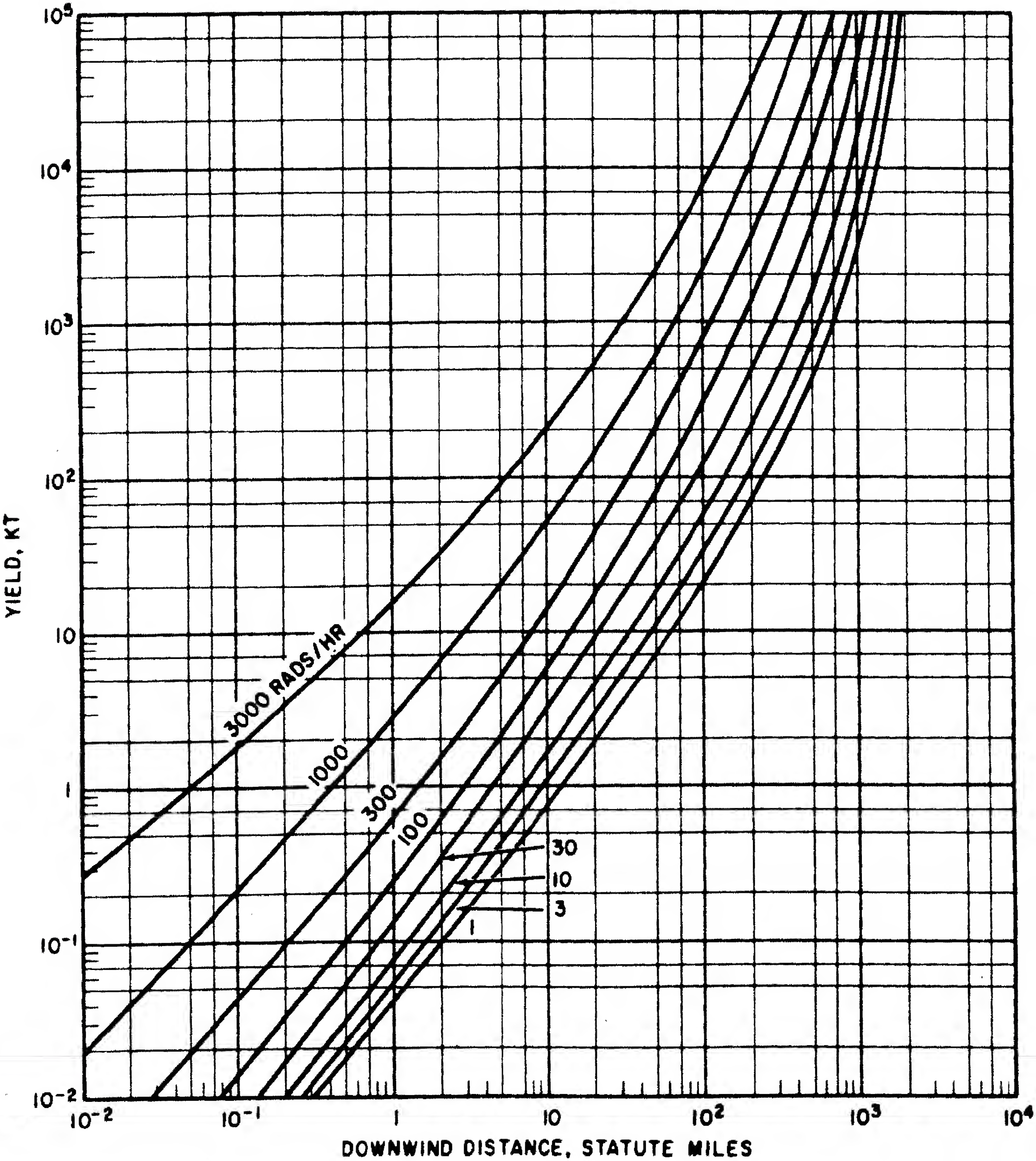


Figure 4-23. Yield vs. Downwind Distance, 10-knot Effective Wind



DOE ARCH

Figure 4-24. Yield vs. Downwind Distance, 20-knot Effective Wind

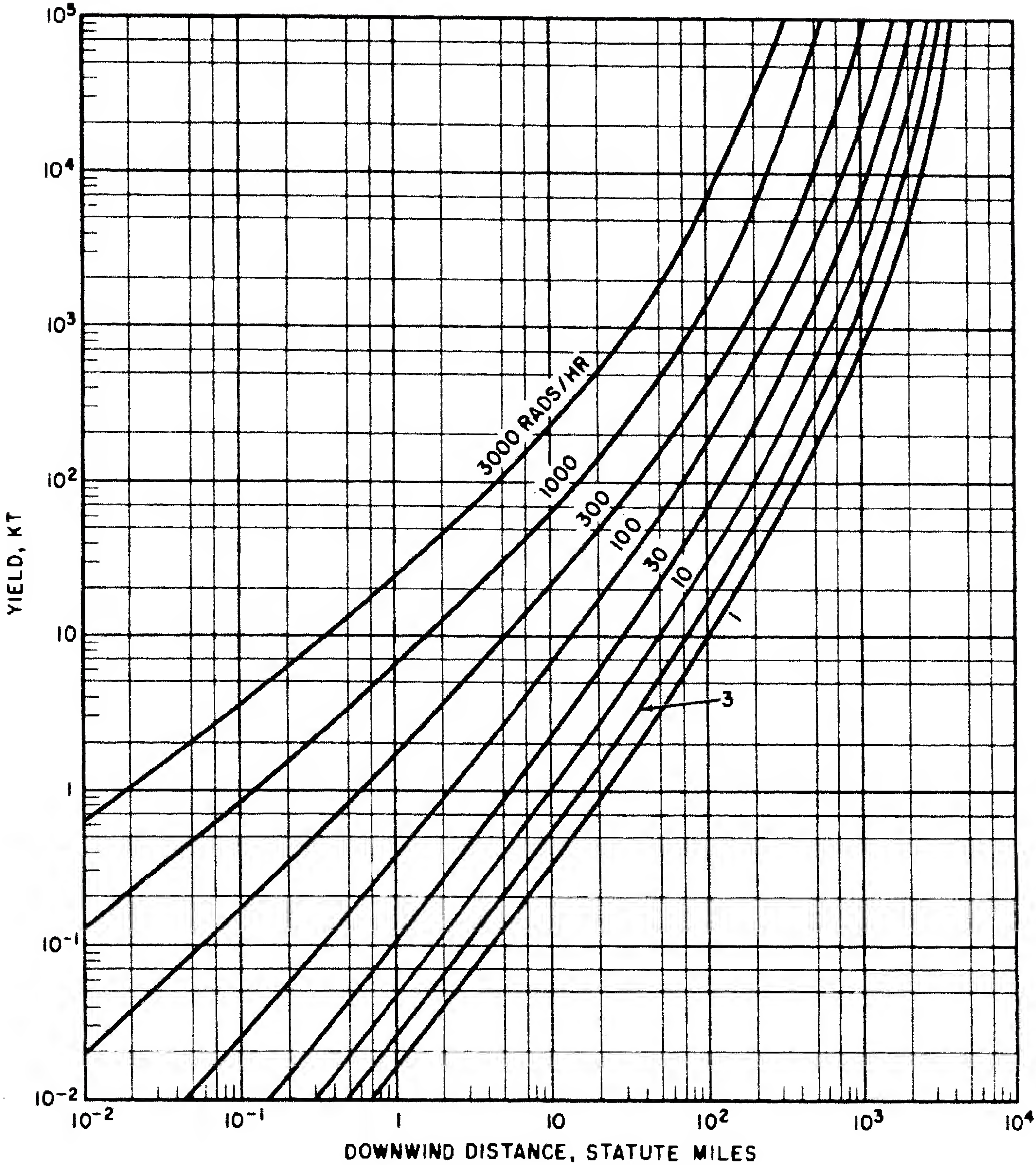


Figure 4-25. Yield vs. Downwind Distance, 40-knot Effective Wind

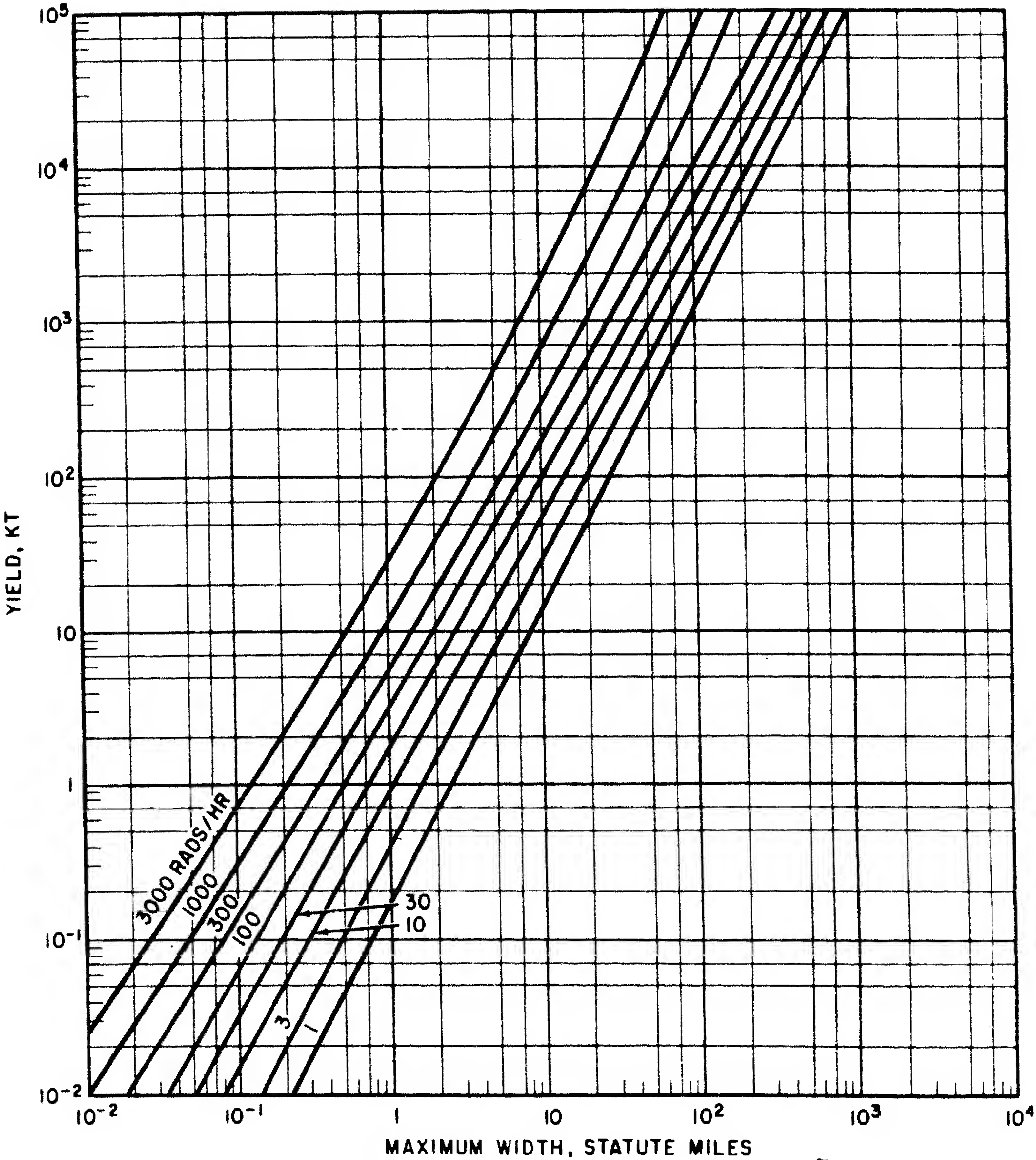


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Figure 4-27. Yield vs. Maximum Width, 10-knot Effective Wind

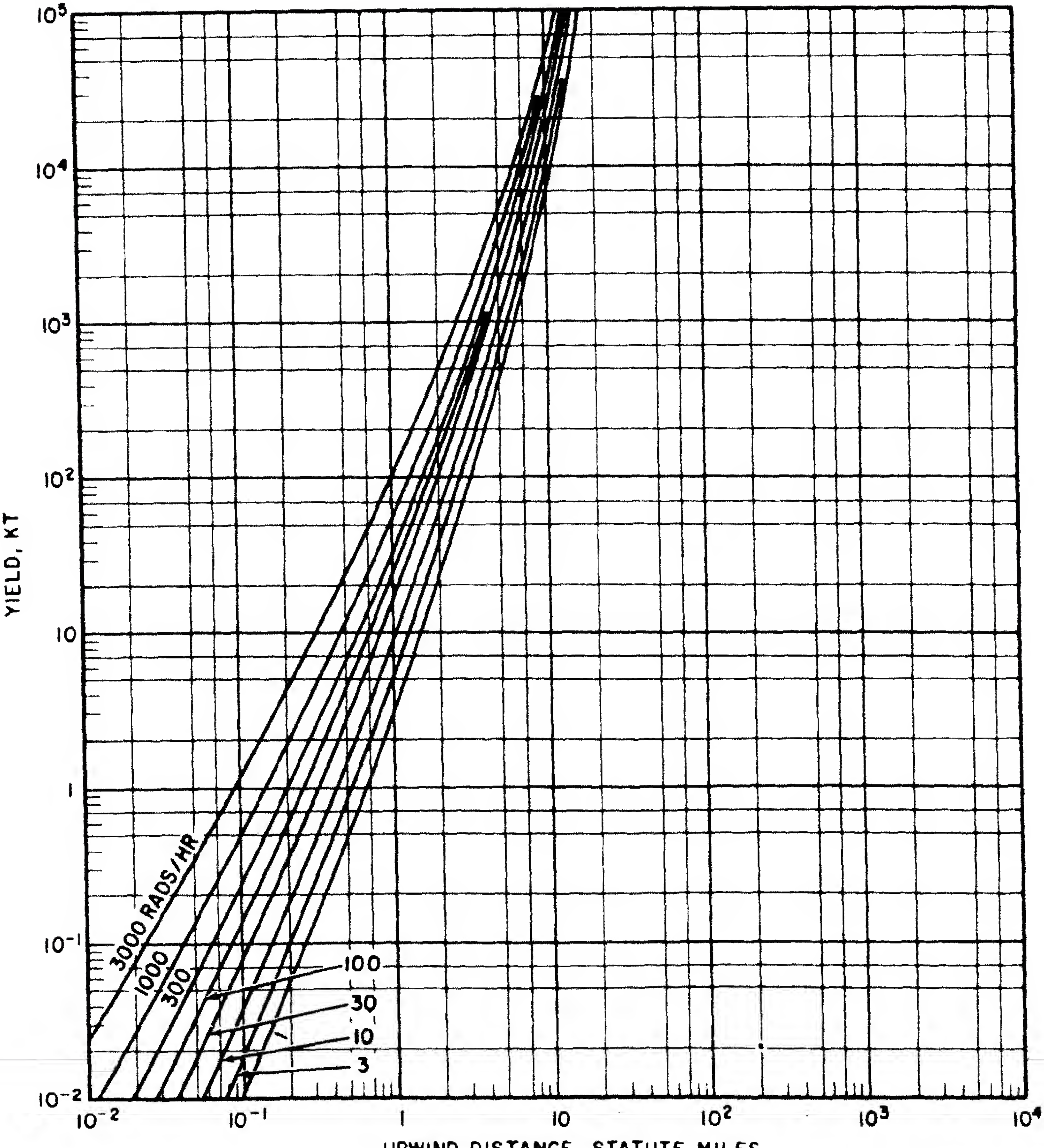


Figure 4-31. Yield vs. Upwind Distance, 10-knot Effective Wind

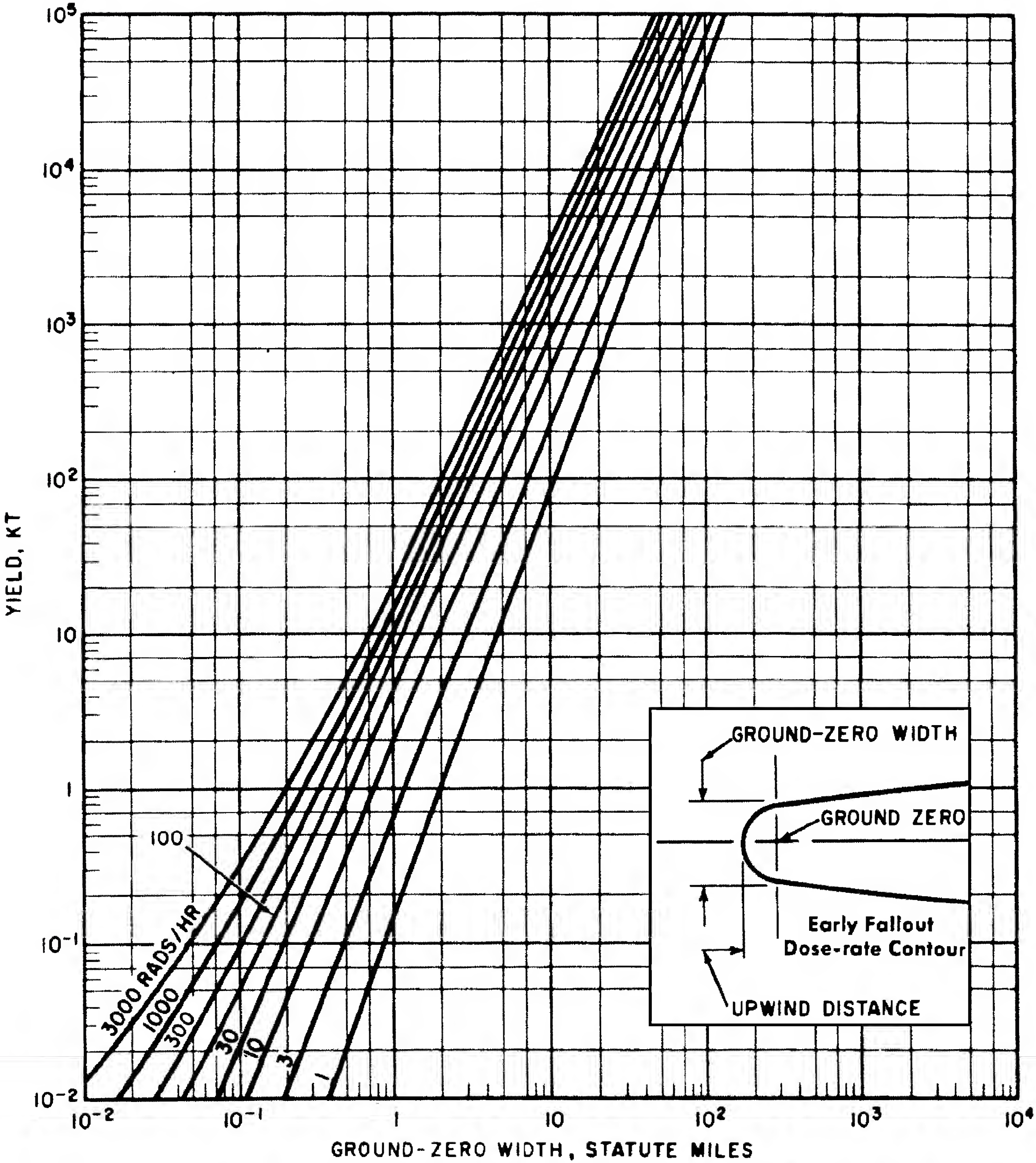


Figure 4-39. Yield vs. Ground-zero Width, 10-knot Effective Wind

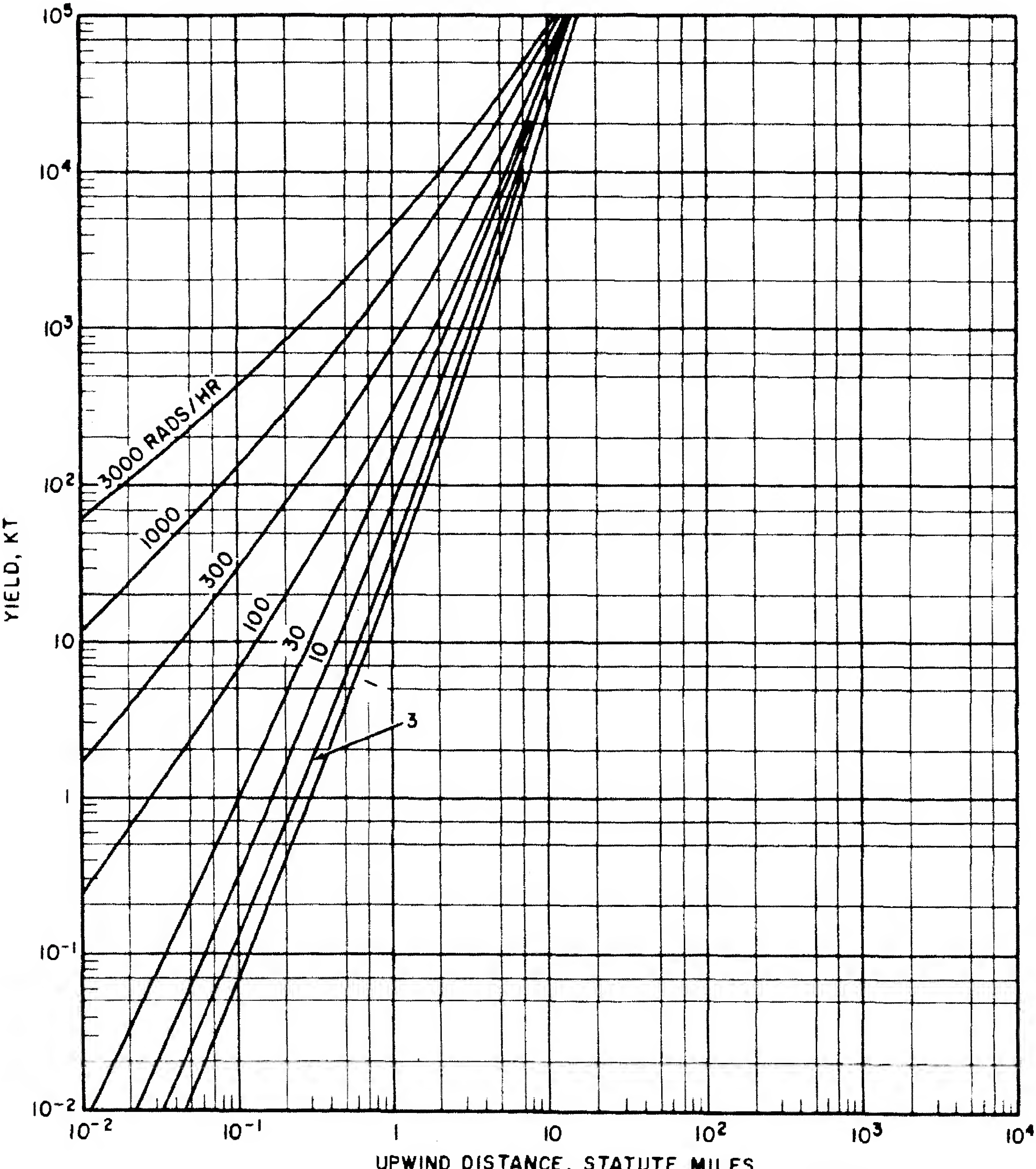


Figure 4-33. Yield vs. Upwind Distance, 40-knot Effective Wind

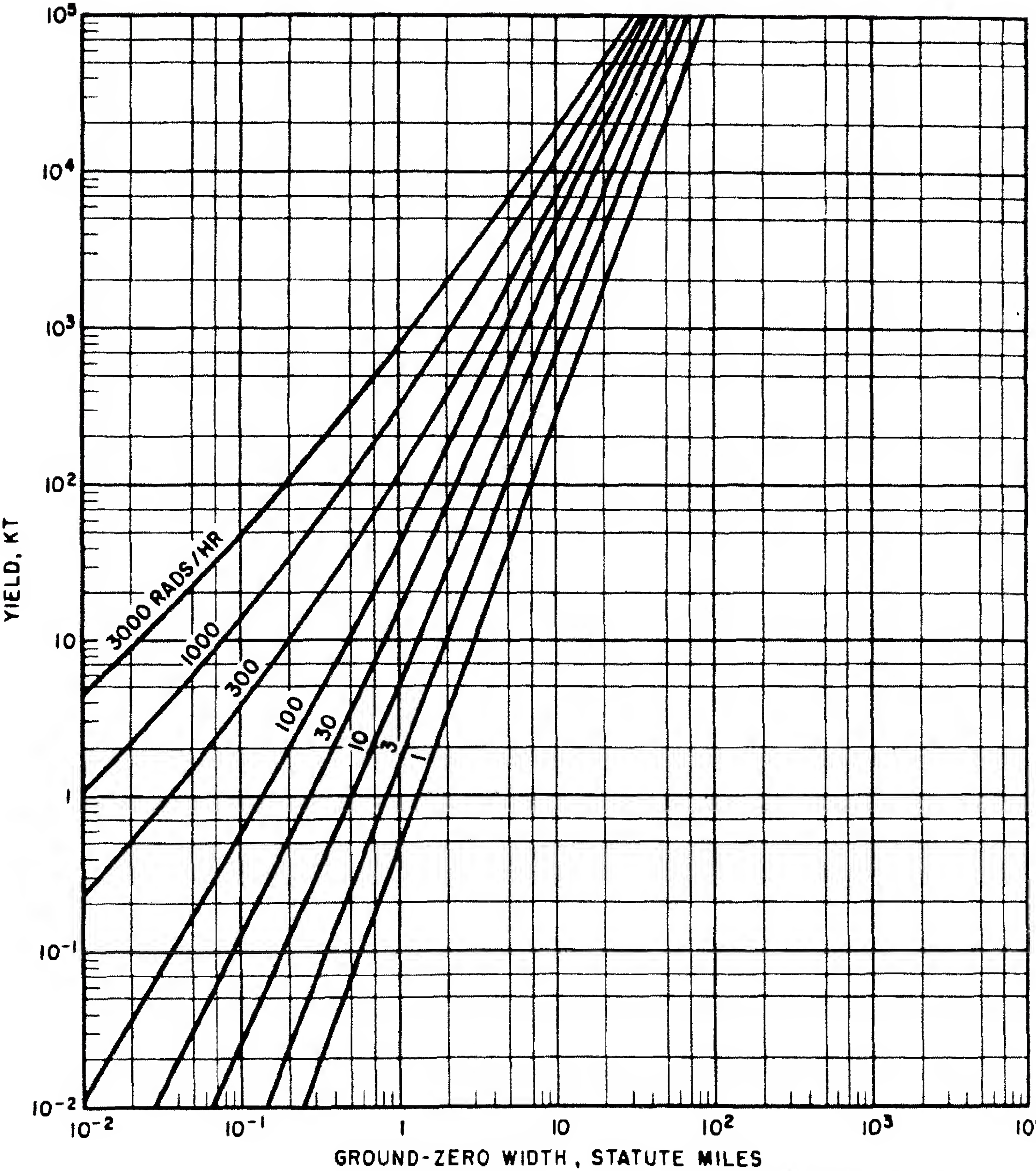


Figure 4-41. Yield vs. Ground-zero Width, 40-knot Effective Wind

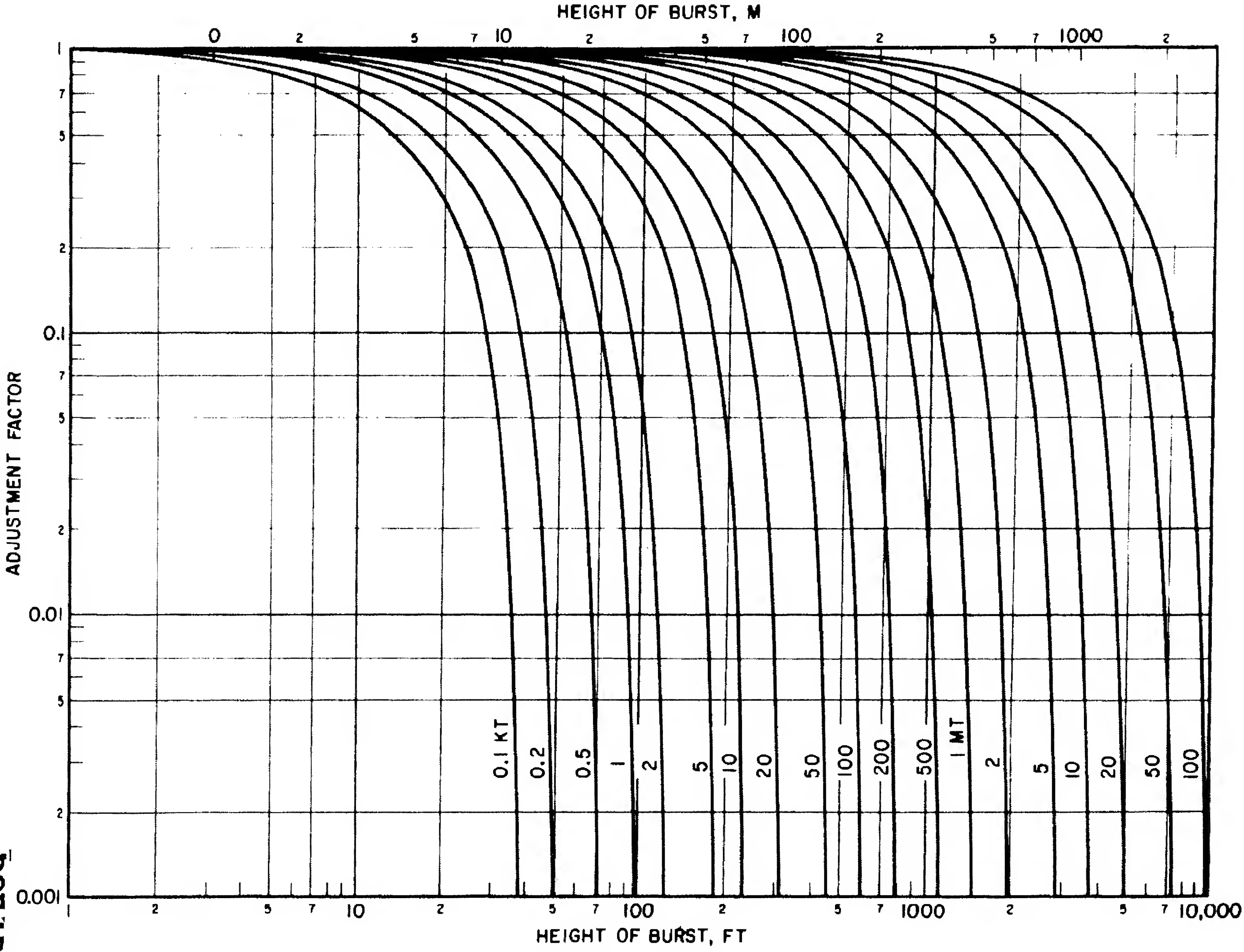


Figure 4-44. Height-of-burst Adjustment Factor for Dose-rate-contour Values Underwater Explosion, 15-knot Wind, Range of Burst Depths, 150 to 1000 ft

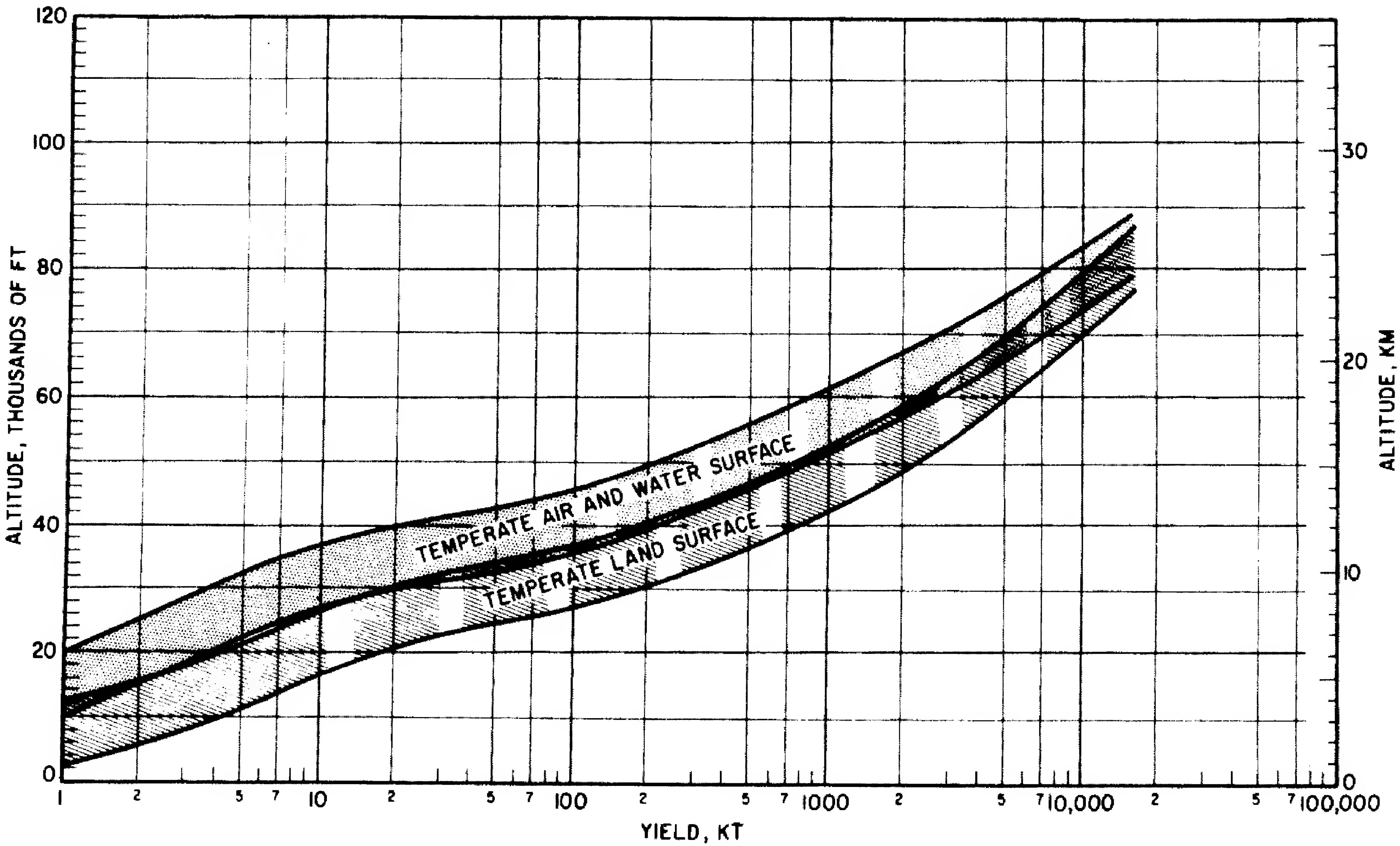
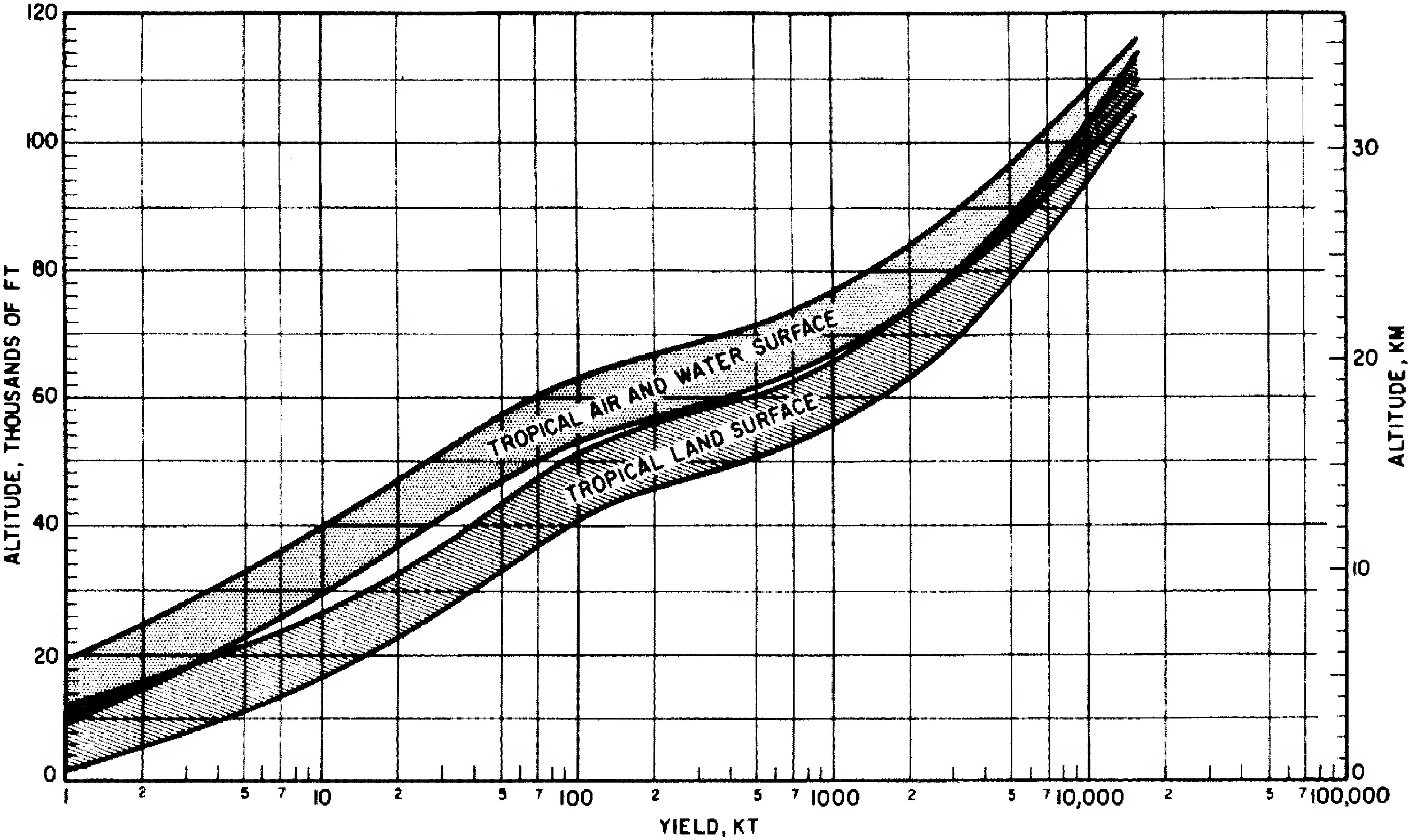


Figure 4-52. Height of Cloud Tops vs. Yield, Temperate Climates



DOE AR

Figure 4-53. Height of Cloud Tops vs. Yield, Tropical Climates

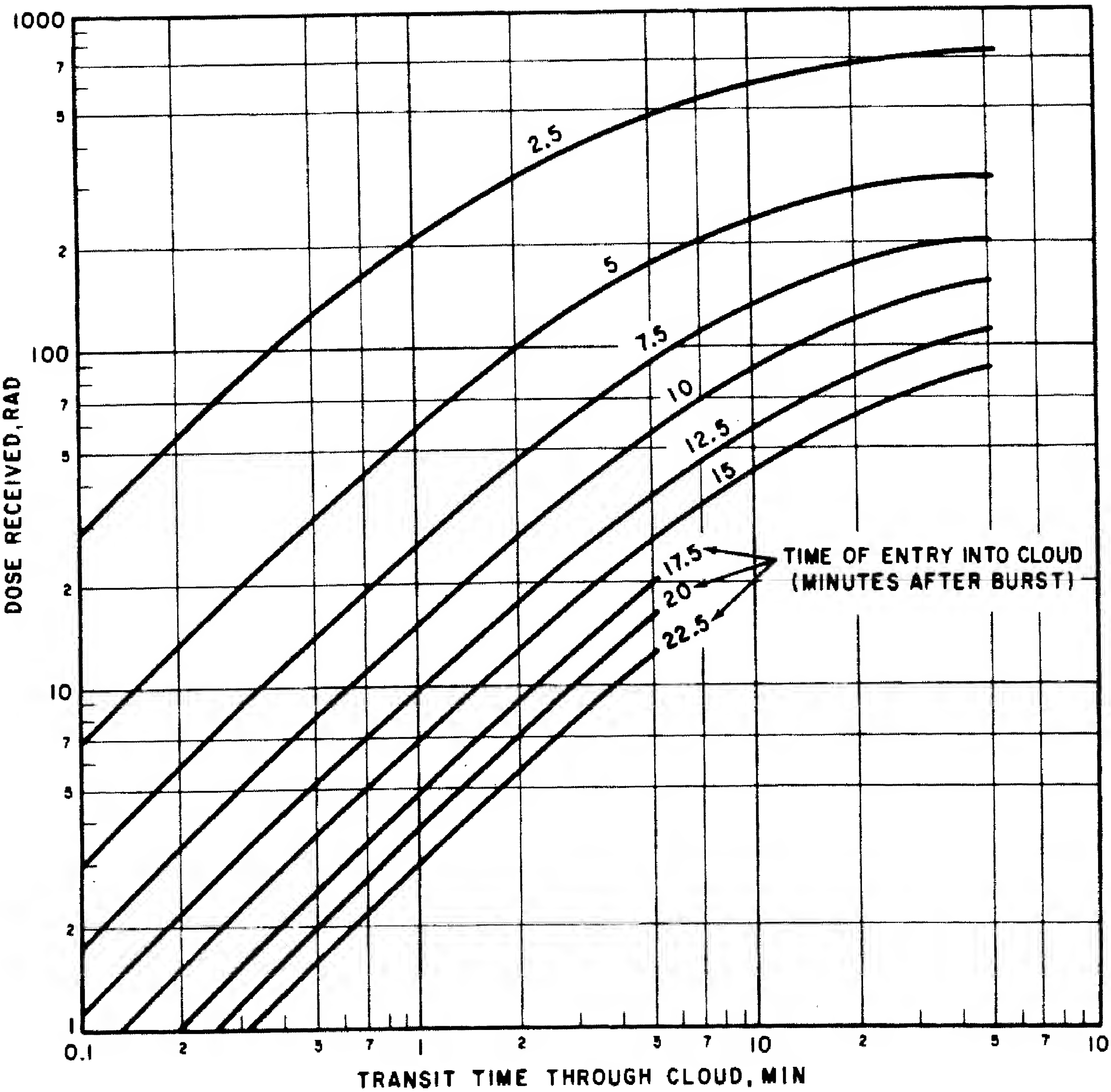


Figure 4-55. Dose Received While Flying Through a Nuclear Cloud vs. Transit Time Through Cloud

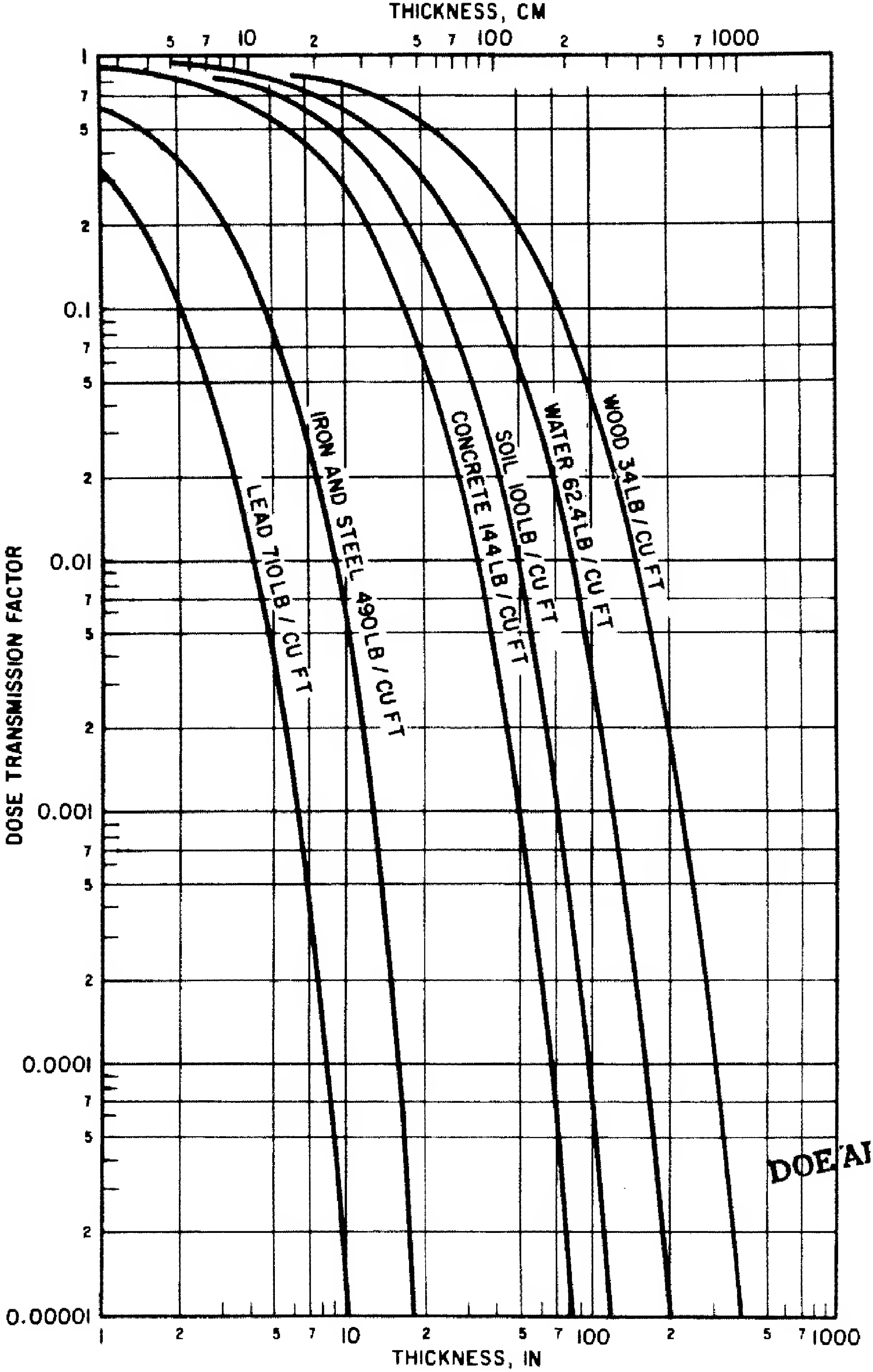


Figure 7-11. Shielding from Initial Gamma Radiation

INITIAL GAMMA RADIATION CORRECTION FACTOR

Table 4-4 Target-burst Factors (f_{tb}) for Various Ranges of Yield and Locations of Burst and Target With Respect to Surface

Burst and Target Orientation	Air Burst Surface Target	Air Burst Air Target	Surface Burst Air Target	Surface Burst Surface Target	Sub-surface Burst Surface Target
Yield	Target-burst Factors				
Less than 400 kt	1	1.3	0.87	0.667	Obtain dose or ranges directly from figure 4-10
0.4 mt to less than 10 mt	1	1.3	1.3	1	
10 mt to 20 mt	1 (use with air-burst-surface target curves)	1.3 (use with air burst-surface target curves)	1.3 (use with surface burst-surface target curves)	1 (use with surface burst-surface target curves)	
20 mt to 40 mt	1	1.3			

Note: Extrapolation to surface burst conditions for yields greater than 20 mt and to yields above 40 mt for any burst conditions is unreliable.

Burst Location—considered an air burst when height of burst is greater than 1500 $W^{1/3}$ ft.

Target Position—considered an air target when target location is greater than 300 ft above the surface.

[redacted]

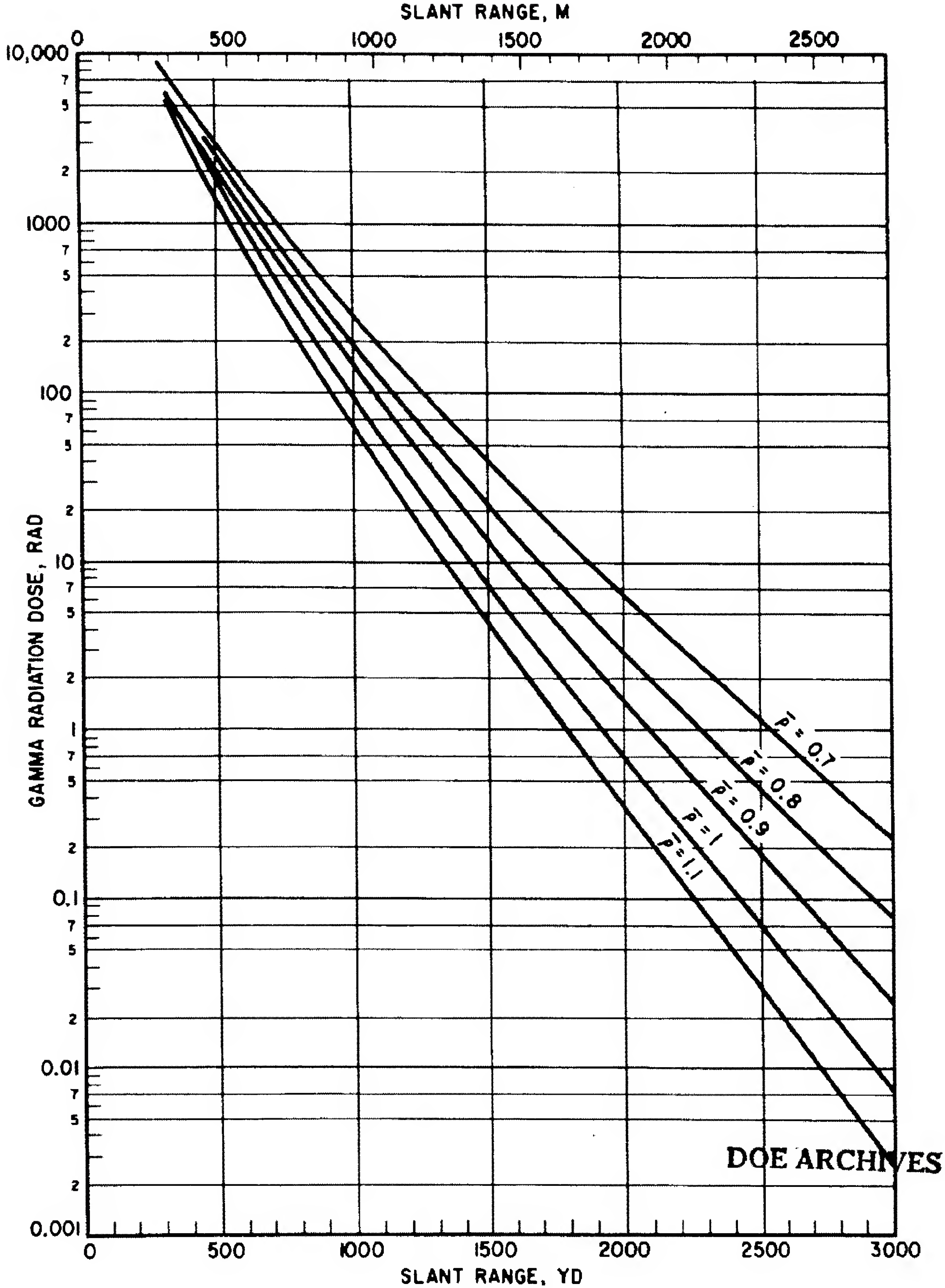


Figure 4-10. Initial Gamma Radiation Dose vs. Slant Range for Various Average Relative Air Densities, 1-kt Underground Burst, Surface Target Depth 17 ft

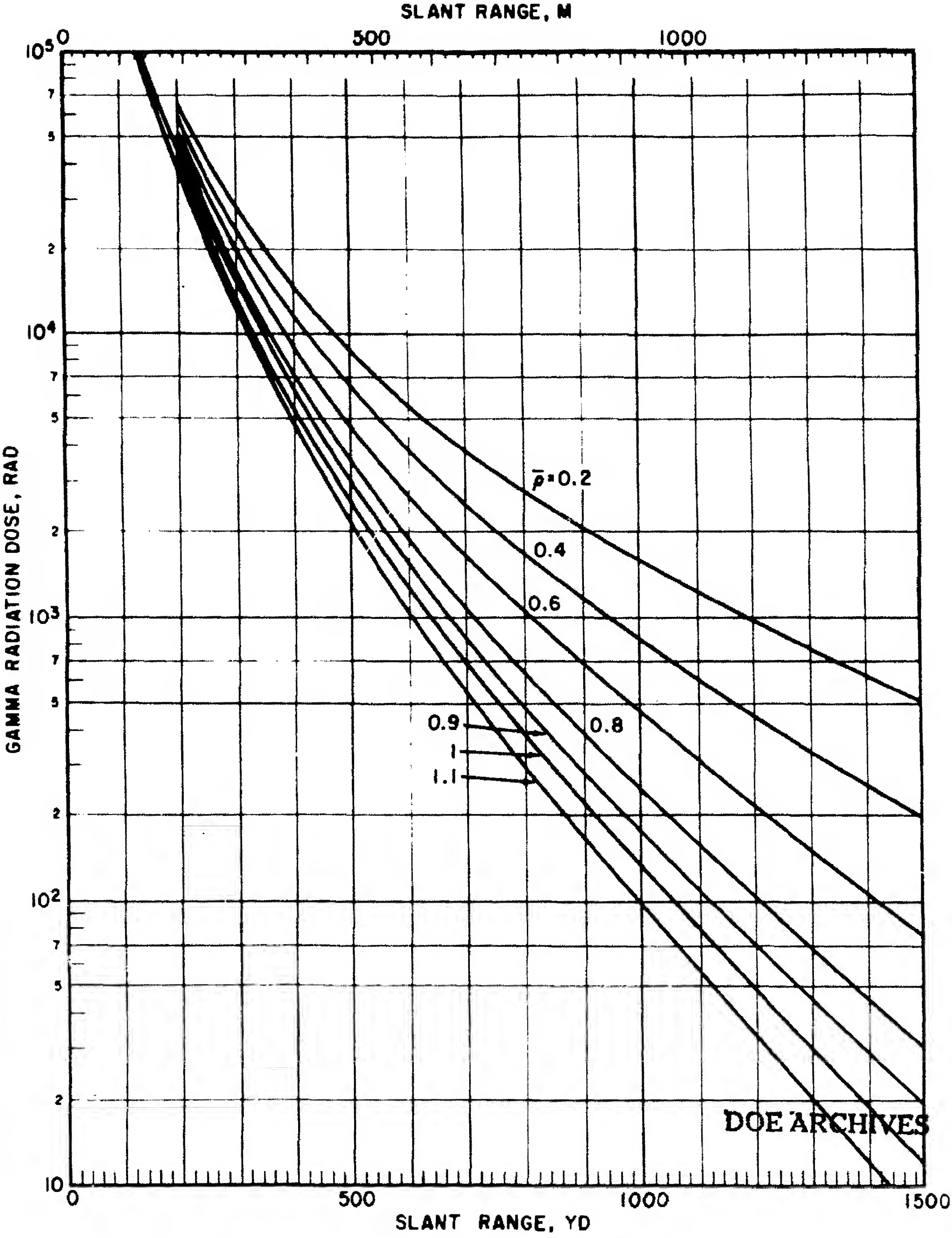


Figure 4-9(A). Initial Gamma Radiation Dose vs. Slant Range (to 1500 yd) for Various Average Relative Air Densities, 1-kt Air Burst-Surface Target

Weapon design strongly influences neutron radiation. Figures 4-17 to 4-20 are given as representative curves applicable to four general weapon categories based upon expected neutron output. Figure 4-17 applies to sub-kiloton yields and the dose is given in units of rads/ton. Figures 4-18 and 4-19 apply to average and high-flux kiloton fission weapons respectively, and the units are in rads/kt. Figure 4-20 applies to fusion weapons and the dose is given in units of rads/mt. From these curves the slant range can be determined at which a weapon of given yield will produce a specified dose; conversely, the yield required to produce a given dose at a desired range can also be found.

Several other factors will influence the dose expected at a given target location. If either the target or the burst is raised above the surface the dose can be expected to increase by approximately 50 percent. If the target is located on the water the dose can be expected to be reduced. Figures 4-17 to 4-19, curves for sub-kiloton and kiloton fission weapons, apply directly to the dose received by a land surface target from a low air burst (fireball does not touch the ground). Figure 4-20 applies directly to the dose received by a land surface target from a surface burst.

Table 4-5 Adjustment Factors for Varying Given Conditions

Condition	Factor
Target location on water surface	0.85
Target location airborne	1.5
Changing burst location from air to surface	0.67
Changing burst location from surface to air	1.5

Scaling. At a given range and relative air density, the neutron dose is proportional to weapon yield. For relative air density, see appendix B.

Example 1.

Given: A high flux 50-kt burst at 2000 ft above a water surface where the average air density between the point of burst and the target location is 0.8.

Find: The maximum neutron dose on the surface of the water at a slant range of 2200 yd.

Solution: From figure 4-19 for $\overline{\rho} = 0.8$ the dose for 1 kt at 2200 yd is 2 rads. The correction factor for the target being on water rather than on land is 0.85.

Answer: Therefore the maximum dose on the surface of the water for 50 kt at 2200-yd slant range and $\overline{\rho} = 0.8$ is $2 \times 50 \times 0.85 = 85$ rads.

Example 2.

Given: A sub-kiloton weapon burst on the ground where the relative air density is 0.9.

Find: The yield required to deliver a neutron dose of 450 rads to the outside of a bunker 500 yd from ground zero.

Solution: From the information given, figure 4-17 (sub-kiloton fission) must be used. Because the given conditions for figure 4-17 are air burst-surface target, the adjustment factor "changing burst location from air to surface—0.67" (see table 4-5) must be used to correct for a surface burst.

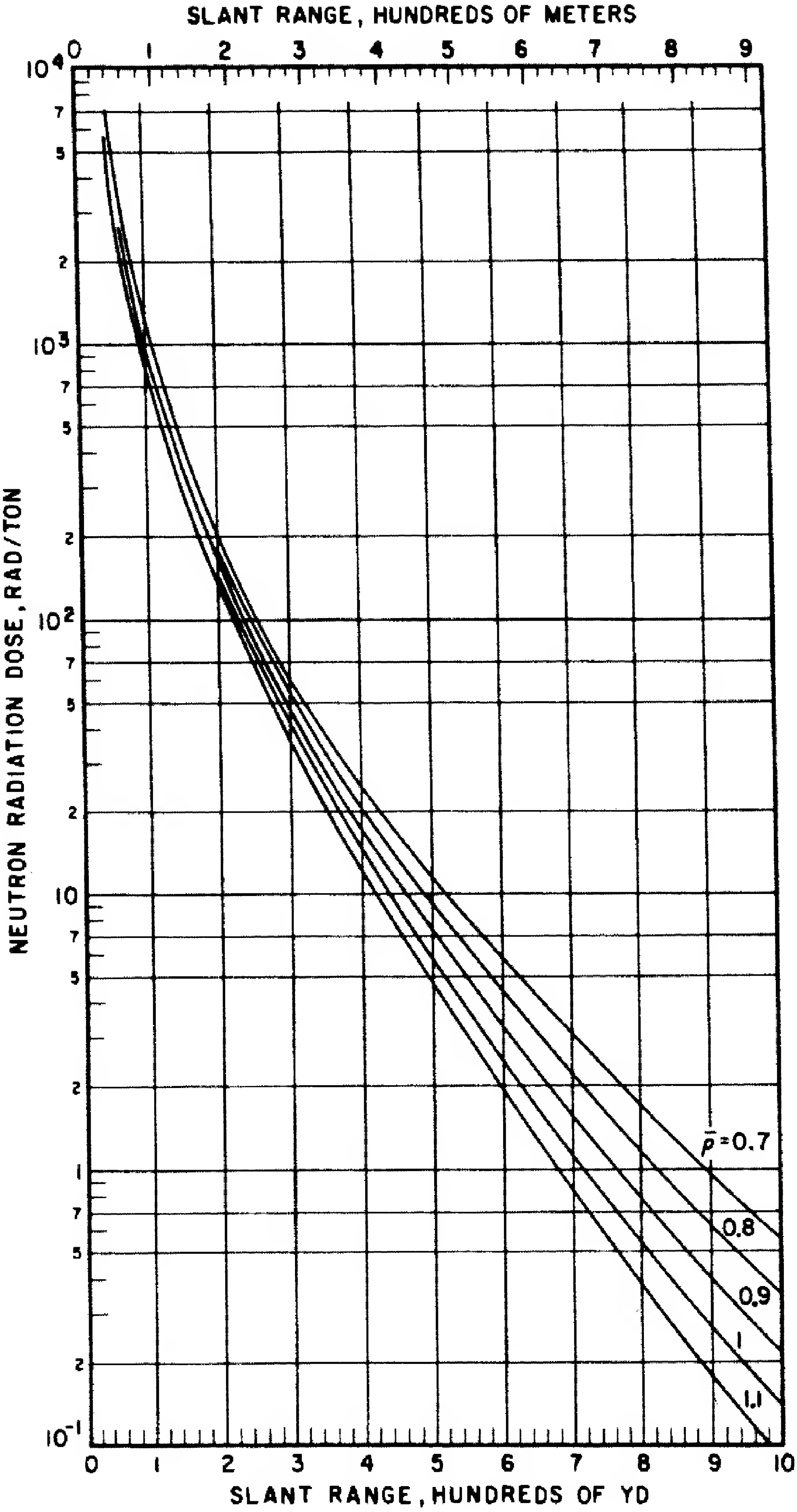
Answer: From figure 4-17 for $\overline{\rho} = 0.9$ read 7.2 rads/ton at 500 yd, air burst-surface target.

$$7.2 \text{ rads/ton} \times 0.67 \text{ (adjustment factor)} = 4.82 \text{ rads/ton delivered to target}$$

$$\frac{450 \text{ rads total}}{4.82 \text{ rads/ton}} = 92 \text{ tons}$$

Reliability. Depending upon weapon design, it is estimated that the dose values given in figures 4-17 through 4-20 may be low by as much as a factor of 2 for certain very high flux designs and high by as much as a factor of 5 for some older weapon designs.

Related Material. See paragraph 4-6.



DO

Figure 4-17. Neutron Radiation Dose vs. Slant Range for Various Average Relative Air Densities, 1-ton (Sub-kiliton Fission) Air Burst-Surface Target

Table 4-1 Chemical Composition of Illustrative Soils

Element	Type I (Liberia, Africa)	Type II (Nevada desert)	Type III (lava, clay, Hawaii)	Type IV (beach, sand, Pensacola, Florida)
	Percentage of soil type (by weight)			
Sodium	—	1.30	0.16	0.001
Manganese	0.008	0.04	2.94	—
Aluminum	7.89	6.90	18.79	0.006
Iron	3.75	2.20	10.64	0.005
Silicon	33.10	32.00	10.23	46.65
Titanium	0.39	0.27	1.26	0.004
Calcium	0.08	2.40	0.45	—
Potassium	—	2.70	0.88	—
Hydrogen	0.39	0.70	0.94	0.001
Boron	—	—	—	0.001
Nitrogen	0.065	—	0.26	—
Sulfur	0.07	0.03	0.26	—
Magnesium	0.05	0.60	0.34	—
Chromium	—	—	0.04	—
Phosphorous	0.008	0.04	0.13	—
Carbon	3.87	—	9.36	—
Oxygen	50.33	50.82	43.32	53.332

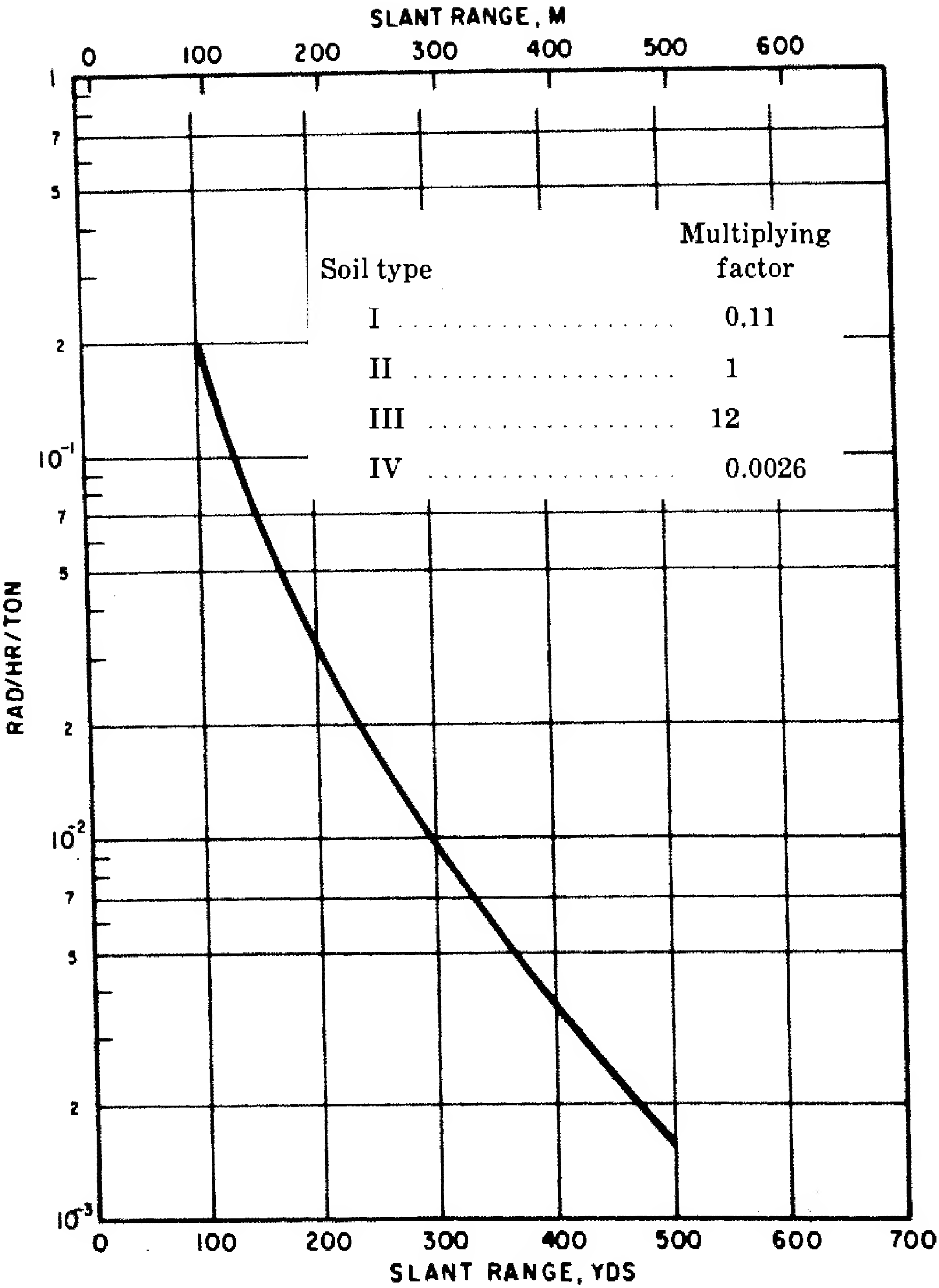


Figure 4-56. Neutron-induced Gamma Activity vs. Slant Range at a Reference Time of 1 hr After Burst, Sub-kiloton Fission Weapons per Ton

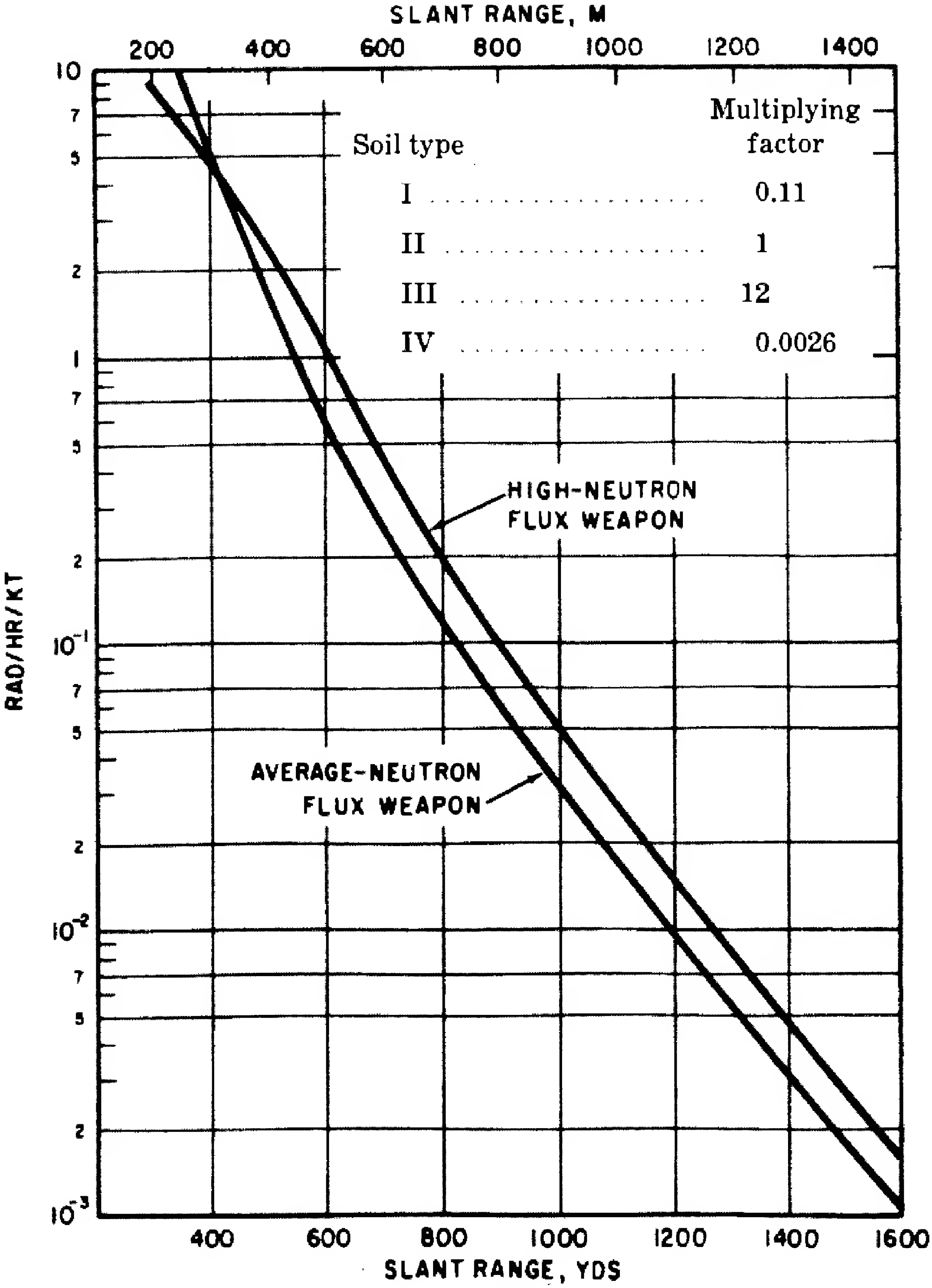


Figure 4-57. Neutron-induced Gamma Activity vs. Slant Range at a Reference Time of 1 hr After Burst, Fission Weapons per kt

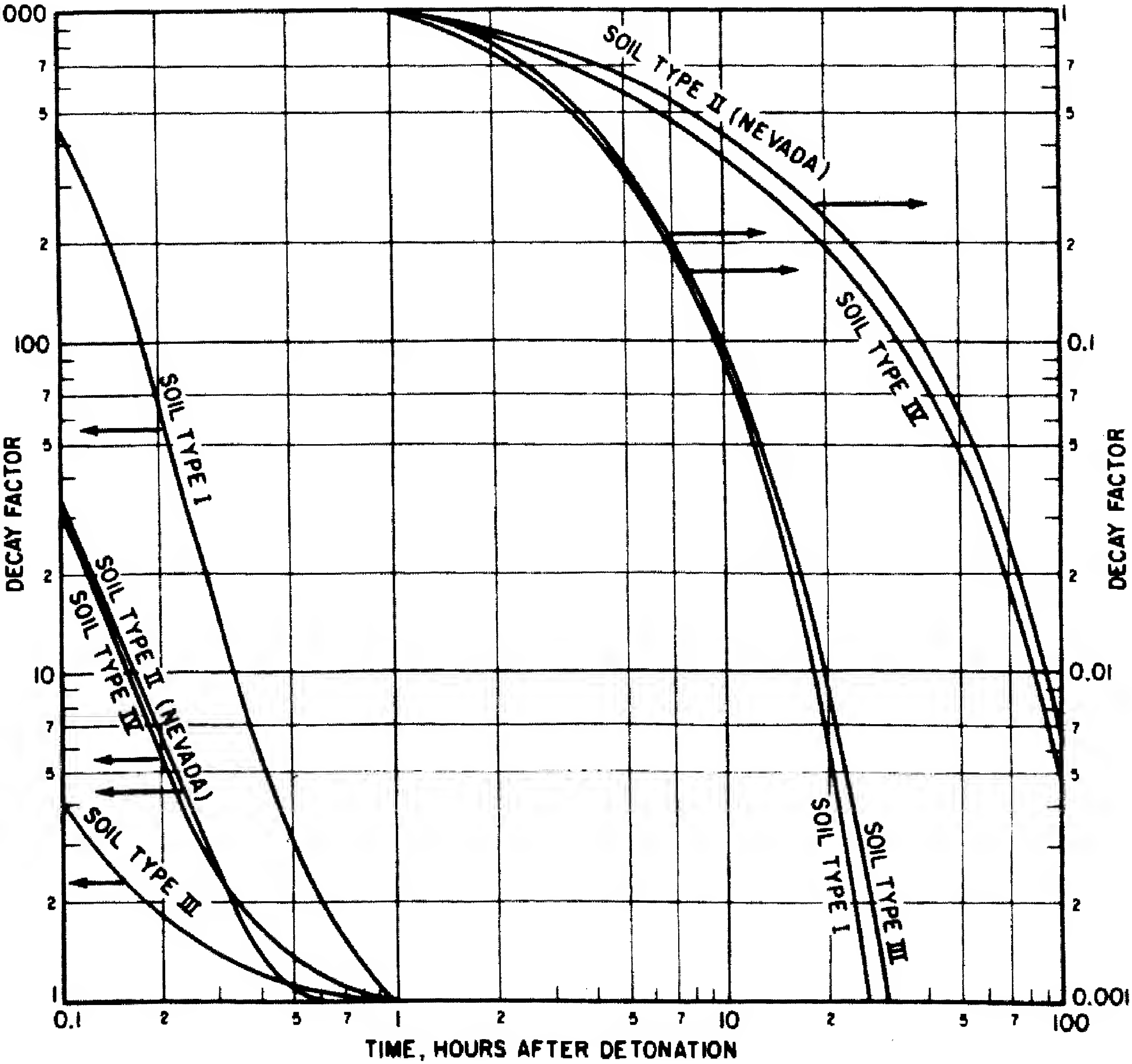


Figure 4-59. Decay Factors for Neutron-induced Gamma Activity

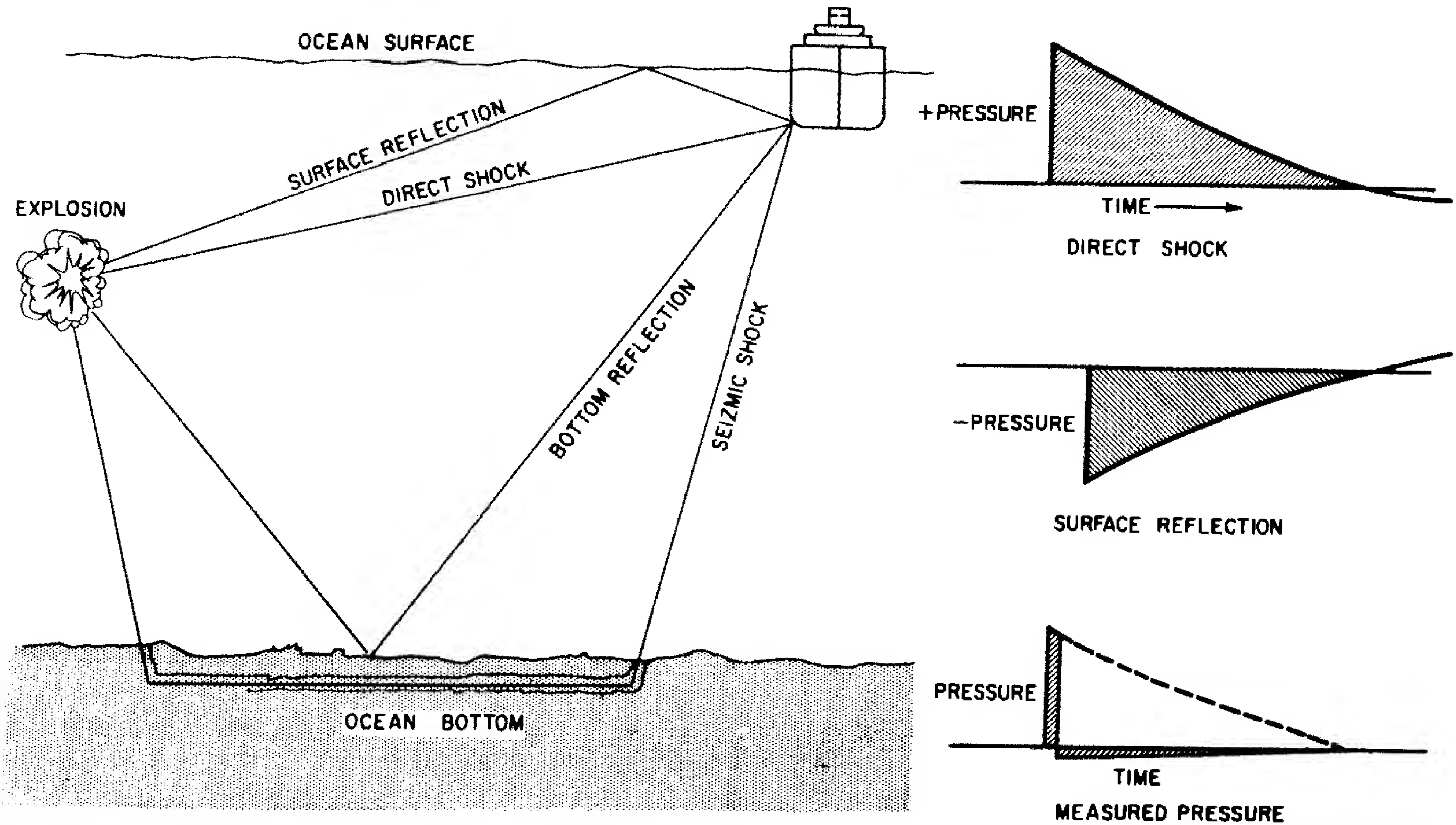


Figure 6-2. Direct and Reffected Shock Waves from an Underwater Burst

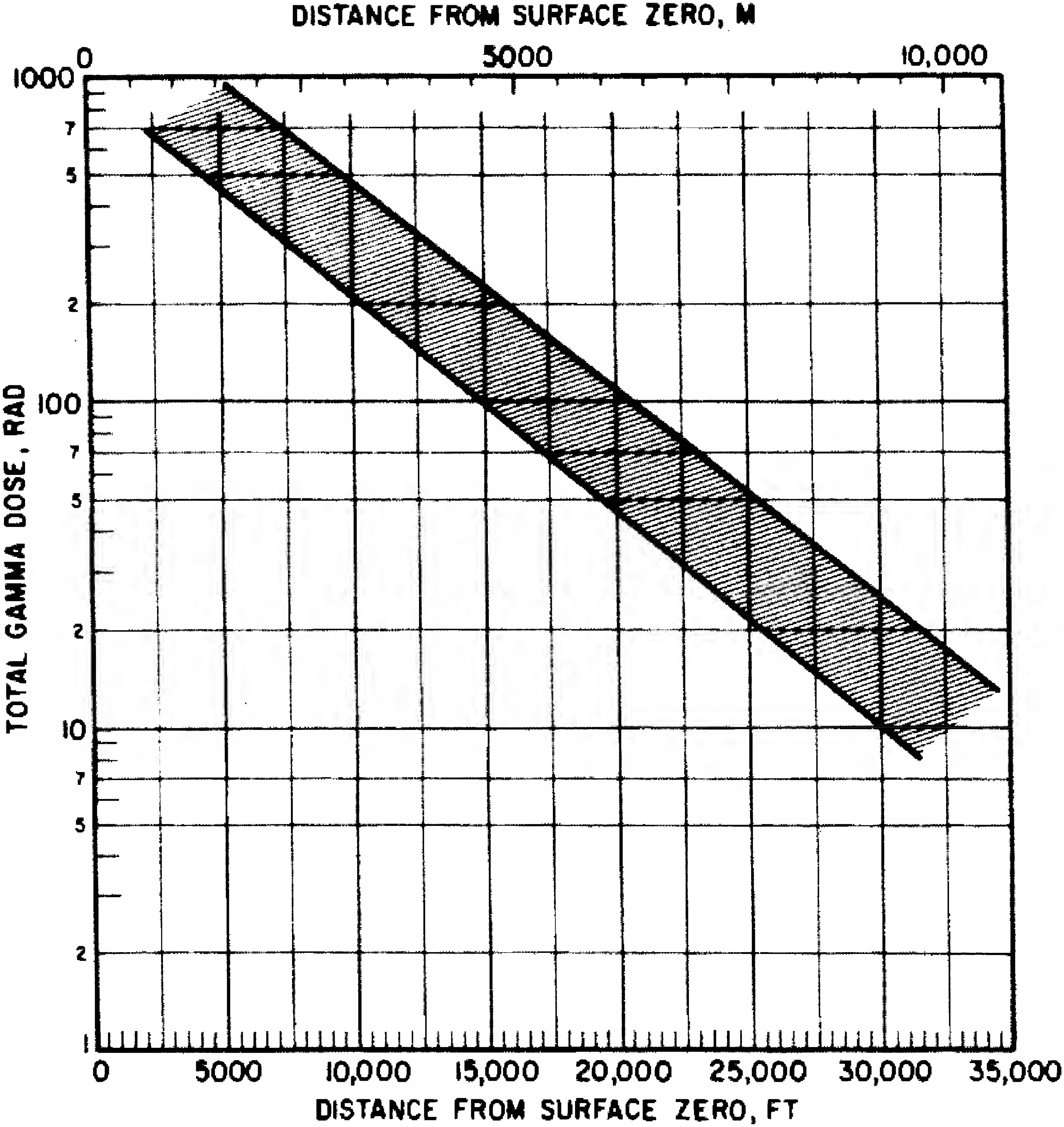


Figure 4-49. Total Dose at the Surface Downwind from a 10-kt Underwater Explosion, 15-knot Wind, Range of Burst Depths, 150 to 1000 ft

[redacted]

some fission products are lost along the path of migration to the surrounding water.

4-28 Fractionation. The radioactive material carried by the base surge, in most cases, fractionates in favor of those fission products having rare-gas ancestors. This probably results from scavenging of the more-refractory fission products by the early subsiding masses of water from the columns of plumes, thereby returning them to the ocean in the immediate vicinity of surface zero.

4-29 Time-space History of the Above-surface Radiation Fields. For all types of underwater explosions, the major source of radiation, to the observer on the surface, is probably the base surge, which can be extremely dangerous to any station it engulfs. Although the total quantity of fission products within the base surge amounts to some 10 to 30 percent of that initially formed, the specific activity is very high because of the early age of the radioactivity. It should be emphasized that *very close* to subsiding columns or plumes, the base surge deposits significant amounts of radioactive material on the surface causing a temporary radiological hazard. The phenomenon is almost entirely transient in nature, similar to being engulfed by a heavy fog.

Evidence to date suggests some distinct differences in the geometry of the base surge depending on whether the explosion is shallow (columns) or deep (plumes). In either case the resulting surge expands radially at a high velocity, and takes the form of a toroid for shallow explosions and is more like concentric multiple toroids for deep explosions. These differences in geometry have two effects on the time-space history of the radiation: as the single toroid passes over a station, the dose rate and dose are delivered in two increments (the forward and rear actions of the ring), as seen in figure 4-6; where concentric multiple toroids are formed, as is the case for the deep explosion, the radiation is delivered over one broad continuous increment, as shown in figure 4-7. The time of passage depends on the maximum extent of the surge periphery, the location of the observer, and the wind speed.

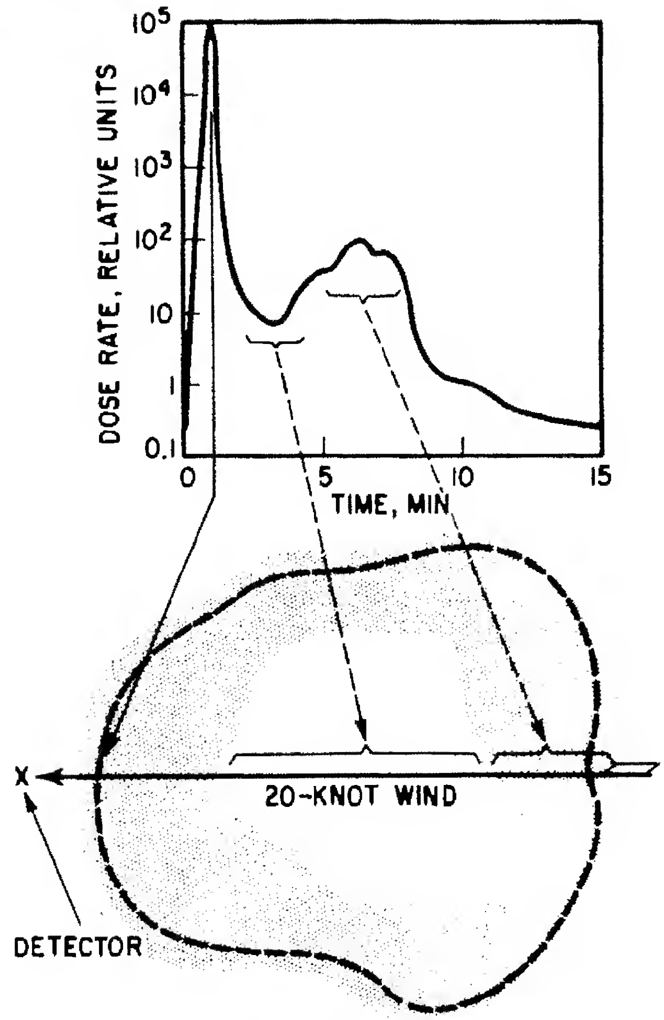


Figure 4-6. Dose Rate vs. Time for a Shallow Underwater Burst

4-30 Water Surface Shot. Nominal-yield bursts on the surface of deep water will resemble the very shallow detonation with the addition of some prompt gamma and neutron activated nitrogen in the atmosphere. For high yields such as a megaton surface burst over shallow water (less than 200 ft deep) the above-surface effects will be similar to those of a land detonation, with the cloud rising to greater heights. Probably, no base surge will develop, but the fallout likely will be different from a land surface burst, and the area of militarily significant fallout will probably be smaller. If the yield is large enough for the cloud to reach the tropopause, the cloud upon reaching this level will rise more slowly and increase in lateral dimensions more rapidly as though flattening out against a ceiling. After reaching maximum altitude, the diameter slowly increases as the cloud drifts downwind. Figure

[redacted]

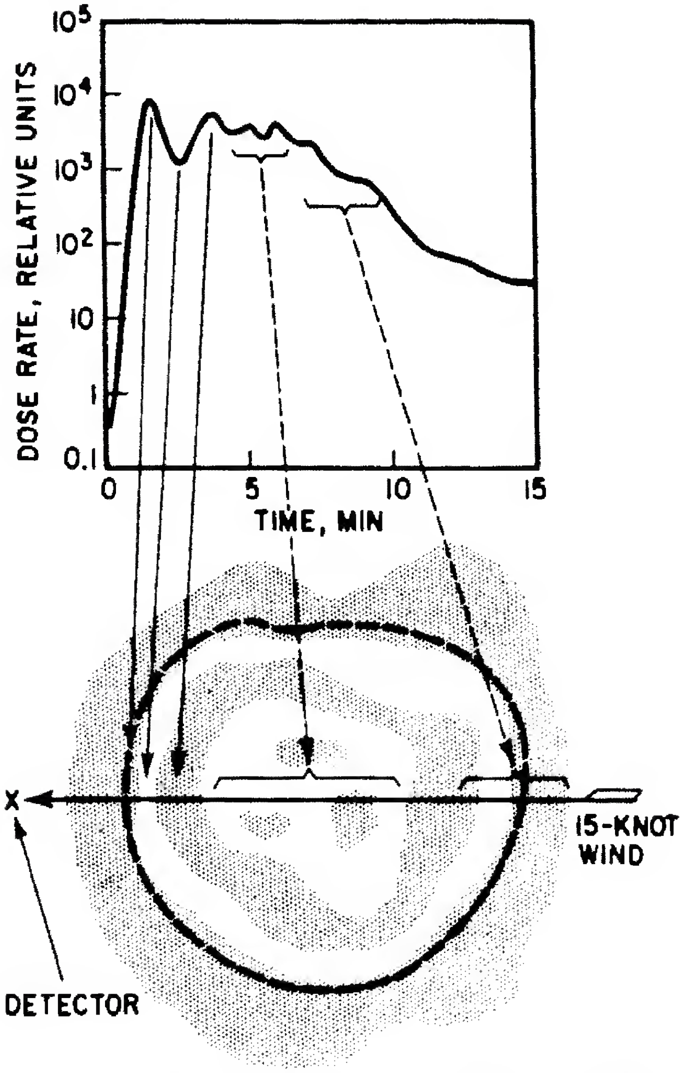


Figure 4-7. Dose Rate vs. Time for a Deep Underwater Burst

4-54 shows the cloud diameter-versus-time relationships. Figure 4-55 gives the dose received by personnel in aircraft flying through an atomic cloud at various times after the detonation.

RESIDUAL BETA RADIATION

In general, the hazard due to residual gamma radiation exceeds the beta hazard for all cases except those in which intimate contact with beta-active materials occurs, as when an individual lies prone in a contaminated area, or when particles fall out directly upon the skin or scalp. For such cases, superficial burns may result, as discussed in paragraph 7-21.

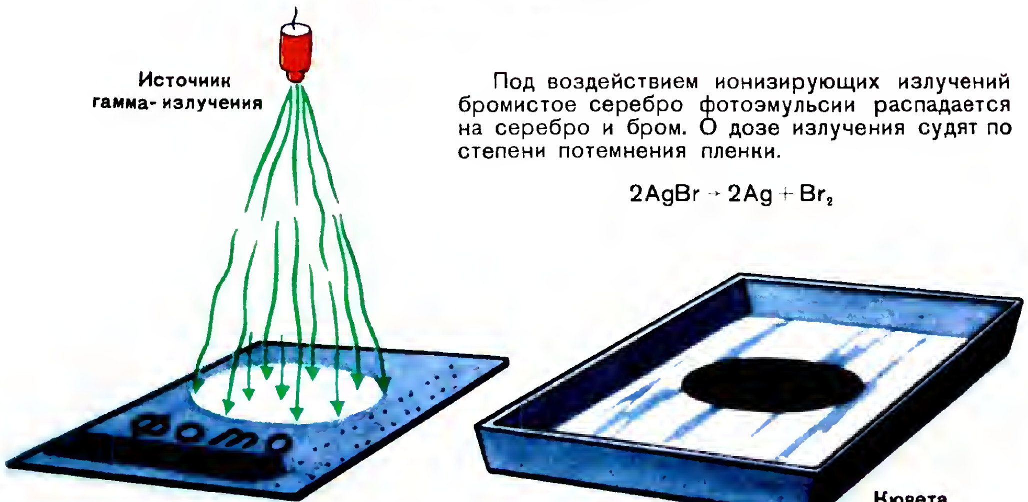
SHIELDING

The dose rates obtained from the contours described, and the total doses derived therefrom, are free-field values that must be reduced if the individual concerned is protected by some shelter. Shielding factors can be estimated from the considerations stated in paragraphs 7-26 through 7-28. For example, personnel in the open in a built-up city area would receive 0.7 of the free-field dose, whereas personnel in shelter such as the basement of a dwelling would receive about 0.1 of the free-field dose.

МЕТОДЫ ОБНАРУЖЕНИЯ РАДИОАКТИВНЫХ ИЗЛУЧЕНИЙ

Обнаружение радиоактивных веществ основывается на способности их излучений ионизировать вещество среды, в которой они распространяются. Ионизация является причиной ряда физических и химических изменений в веществе. Эти изменения могут быть сравнительно просто обнаружены и измерены несколькими методами.

ФОТОГРАФИЧЕСКИЙ МЕТОД



Под воздействием ионизирующих излучений бромистое серебро фотоэмульсии распадается на серебро и бром. О дозе излучения судят по степени потемнения пленки.

$$2AgBr \rightarrow 2Ag + Br_2$$

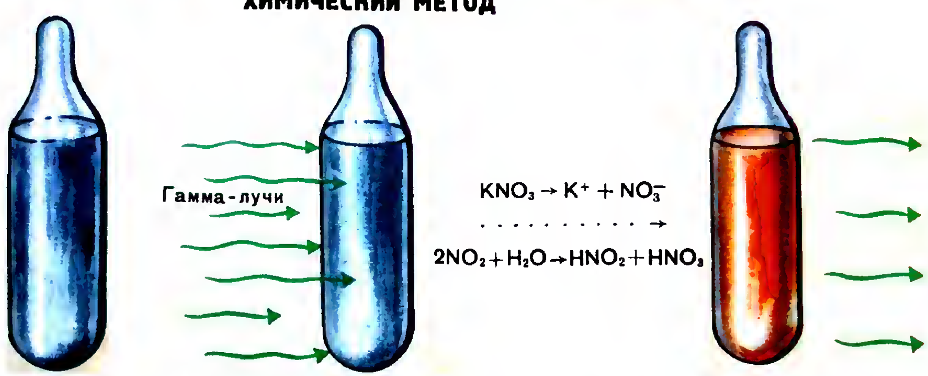
СЦИНТИЛЛЯЦИОННЫЙ МЕТОД

Некоторые вещества (сернистый цинк, йодистый натрий) под воздействием ионизирующих излучений светятся. Количество вспышек пропорционально мощности дозы излучения и регистрируется с помощью специальных приборов — фотоэлектронных умножителей.

Russian radiation instruments (colour changing chemicals, ion chambers, etc)

ХИМИЧЕСКИЙ МЕТОД

Раствор KNO_3

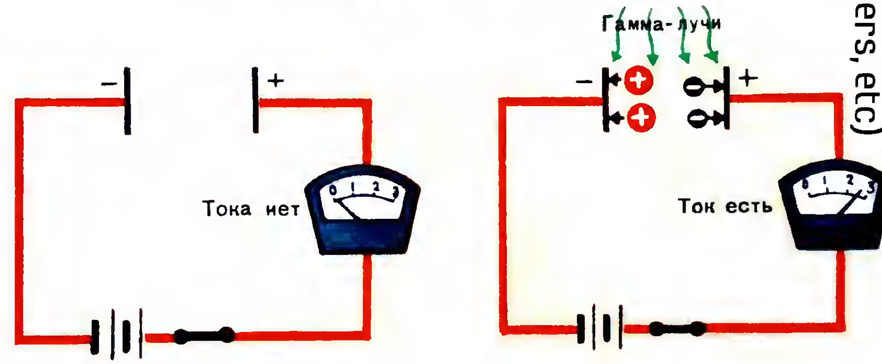


$$KNO_3 \rightarrow K^+ + NO_3^-$$
$$\cdots\cdots\cdots \rightarrow$$
$$2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$$

Некоторые сложные химические вещества под воздействием ионизирующих излучений распадаются.

Количество образовавшейся, например, азотистой кислоты пропорционально дозе излучения и определяется по степени окраски добавляемого в раствор индикатора.

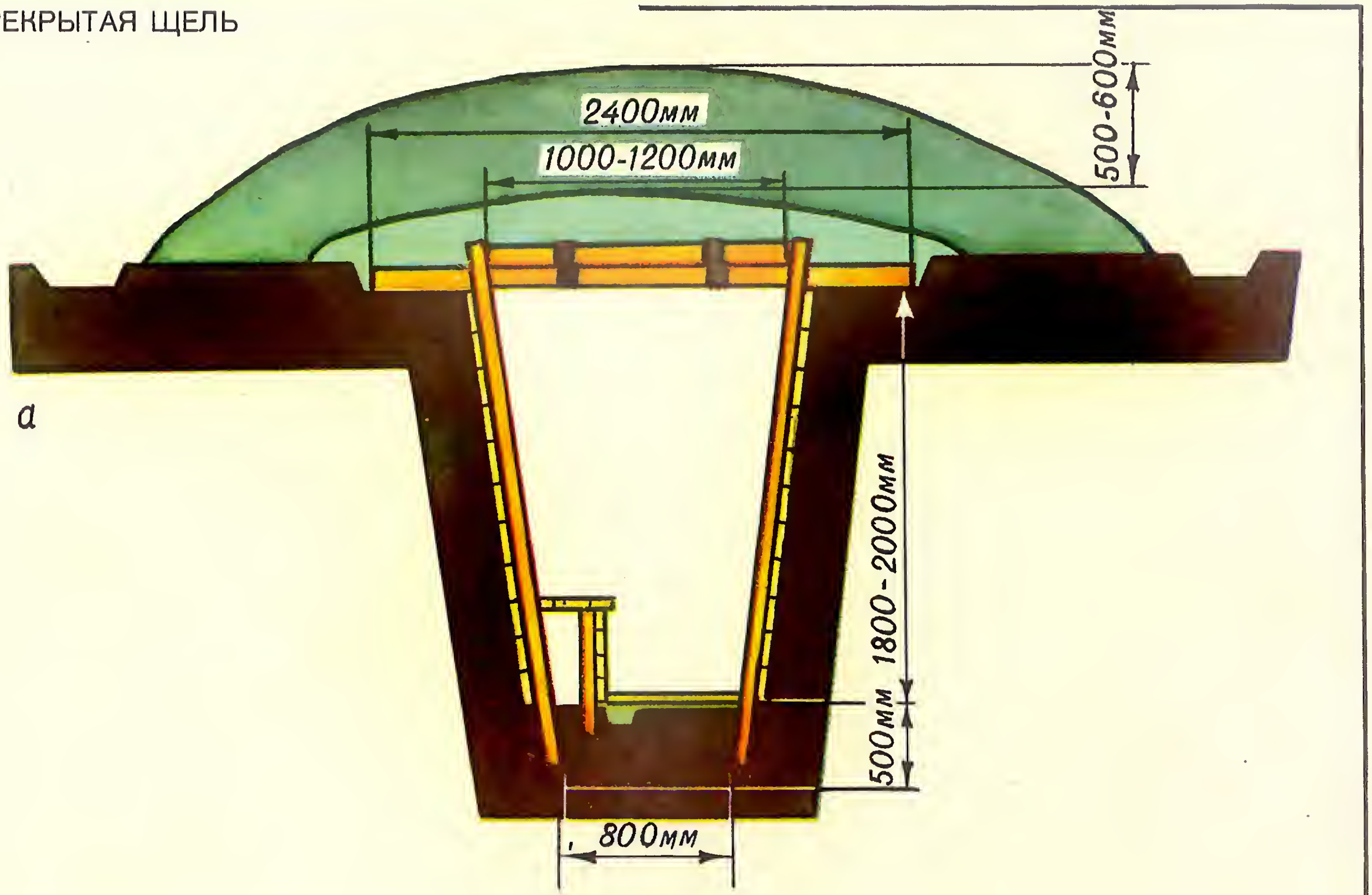
ИОНИЗАЦИОННЫЙ МЕТОД



Под воздействием излучений в газовом объеме происходит ионизация молекул газа. При наличии электрического поля в ионизированном газовом объеме возникает ионизационный ток, по величине которого судят о мощности дозы.

Ионизационный метод используется почти во всех современных полевых дозиметрических приборах.

ПЕРЕКРЫТАЯ ЩЕЛЬ



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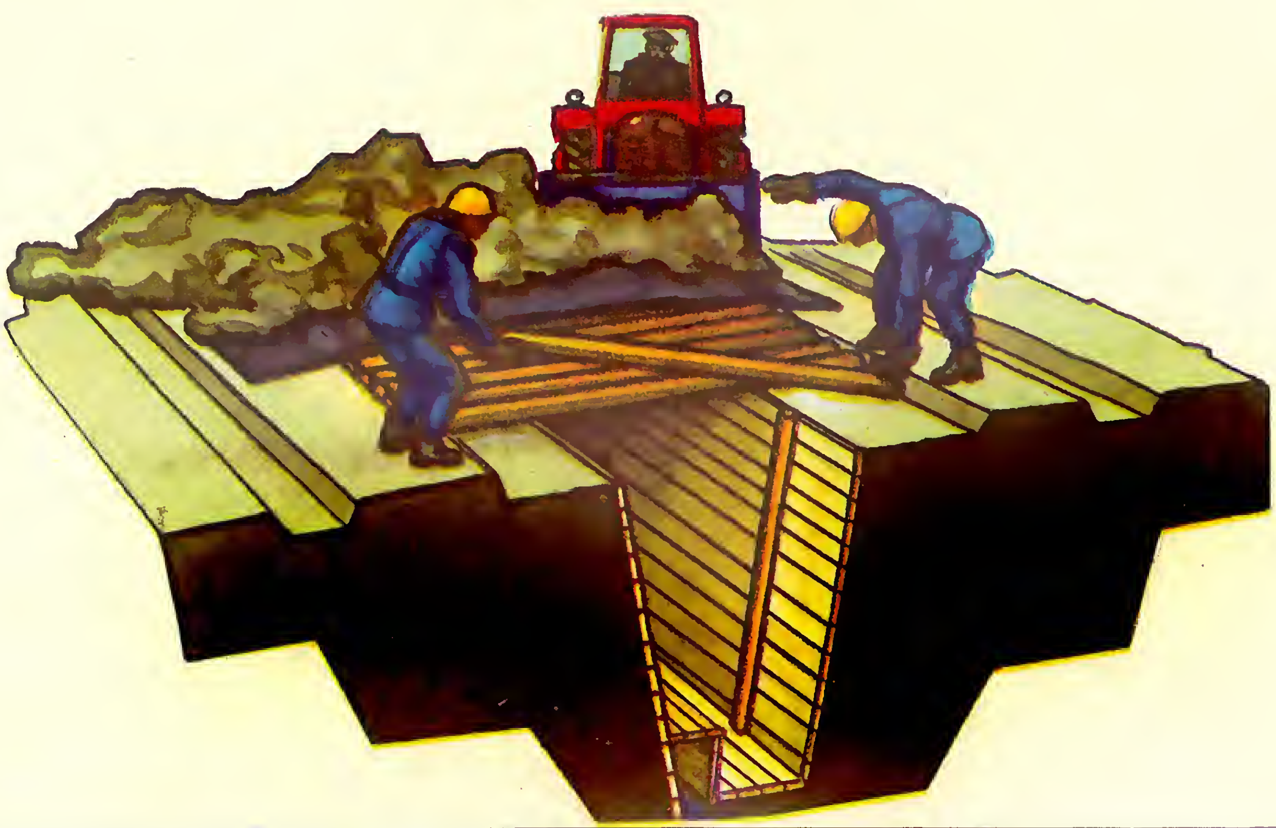

б

Russian nerve gas atropine injection

Russian civil defence drill

RUSSIAN CIVIL DEFENCE: GAS MASKS, RESCUE TEAMS, BASEMENT SHELTERS AND EVACUATION